THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 18 APRIL, 1939 Number 4

LAWRENCE E. BARRINGER

For story, see page 114

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THE BULLETIN OF THE AMERICAN CERAMIC SOCIETY

Volume 18 **April, 1939** **Number 4**

CONTENTS

PROGRAM OF THE FORTY-FIRST ANNUAL MEETING, AMERICAN CERAMIC SOCIETY

Meeting Schedules—Directory—Program Outline—Chicago Local Committees **113**

Edward Orton, Jr., Fellow Memorial Lecture
L. E. Barringer, speaker—Data on Activities of Mr. Barringer 114

General Sessions Programs (Author Index, p. 140)
Symposium on Importance of Thermal History 115
Symposium on Glaze Properties 116
Round Table Discussion: Methods of Analysis of Silicates and Silicate Products 139

Industrial Divisions Programs
Art Division (Room 430A) 118
Enamel Division (South Ball Room) 120
Glass Division (North Ball Room) 123
Materials and Equipment Division (P.D.R. No. 1) 127
Refractories Division (North Assembly Room) 129
Structural Clay Products Division (P.D.R. No. 2) 133
White Wares Division (West Ball Room) 136

Author Index to Program Papers **140**

Paper
Ring-Section Examination of Glass Containers—V. C. Swicker 143

Activities of the Society
National Ceramic Exhibition 142
What to See in Chicago and Vicinity: Photos, Art Institute—Field Museum 148
Photos, Northwestern University (downtown buildings, Chicago)—Oriental Institute, University of Chicago 149
Institute of Ceramic Engineers 150
Golden Gate General Meeting, San Francisco, Calif.: Advance Program Announcement 150
Local Sections: Central Ohio—Southern California—Pittsburgh 152
Student Branches: Ohio State University—Pennsylvania State College 152
Directory of Industrial Research Laboratories 152
Necrology: G. A. Hodson 153
Notes: H. E. Ebright with Chicago Vitreous—Research Fellowships in Coal and Nonmetallics—Franklin Institute Honors New Safety Glass Development 153
Division: Official Personnel 156
Trustees—Division Officers—Local Section Officers 157

Roster of Corporation Members **154**

Advertisers' Index **8**

Buyers' Guide **13–16**

Publication Office: 20th & Northampton Sts., Easton, Pa.
Editorial and Advertising Office: 2525 N. High St., Columbus, Ohio.
Executive Office: 2525 N. High St., Columbus, Ohio.
Committee on Publications: J. D. SULLIVAN, *Chairman;* E. E. MARBAKER, E. DE F. CURTIS, W. W. WINSHIP, ROSS C. PURDY.

Entered as second-class matter at the post office at Easton, Pa., under the act of March 3, 1879. Published monthly.
Subscription $1.50 a year. Single numbers twenty-five cents.
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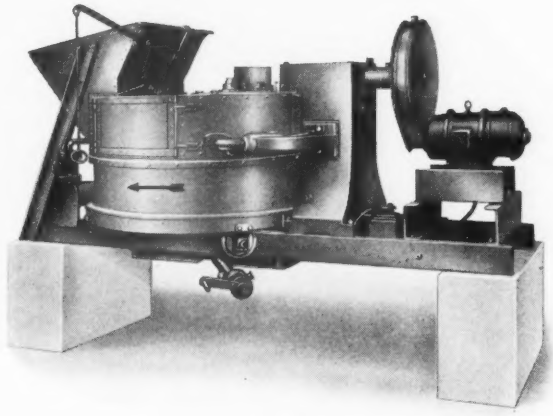

The "Lancaster" EMG-4 Mixer. A dust proof, closed pan type with stationary hopper. For capacities to 72 gals. or 9 cu. ft.

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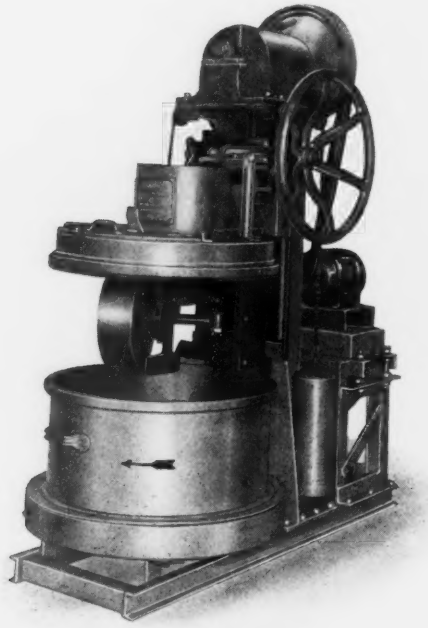

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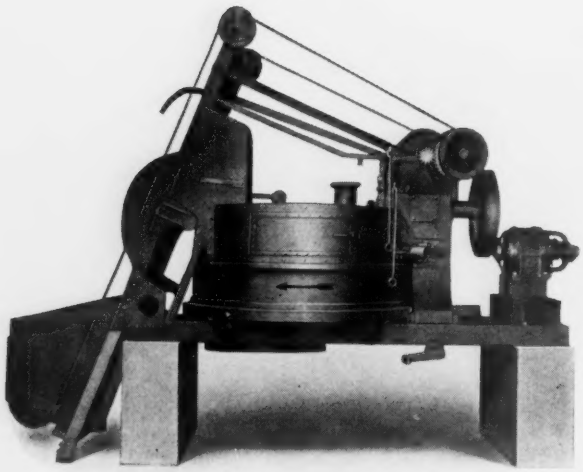
Visit the "Lancaster" display in room 512 at Hotel Stevens during the A. C. S. Meeting in Chicago, April 17 to 21.



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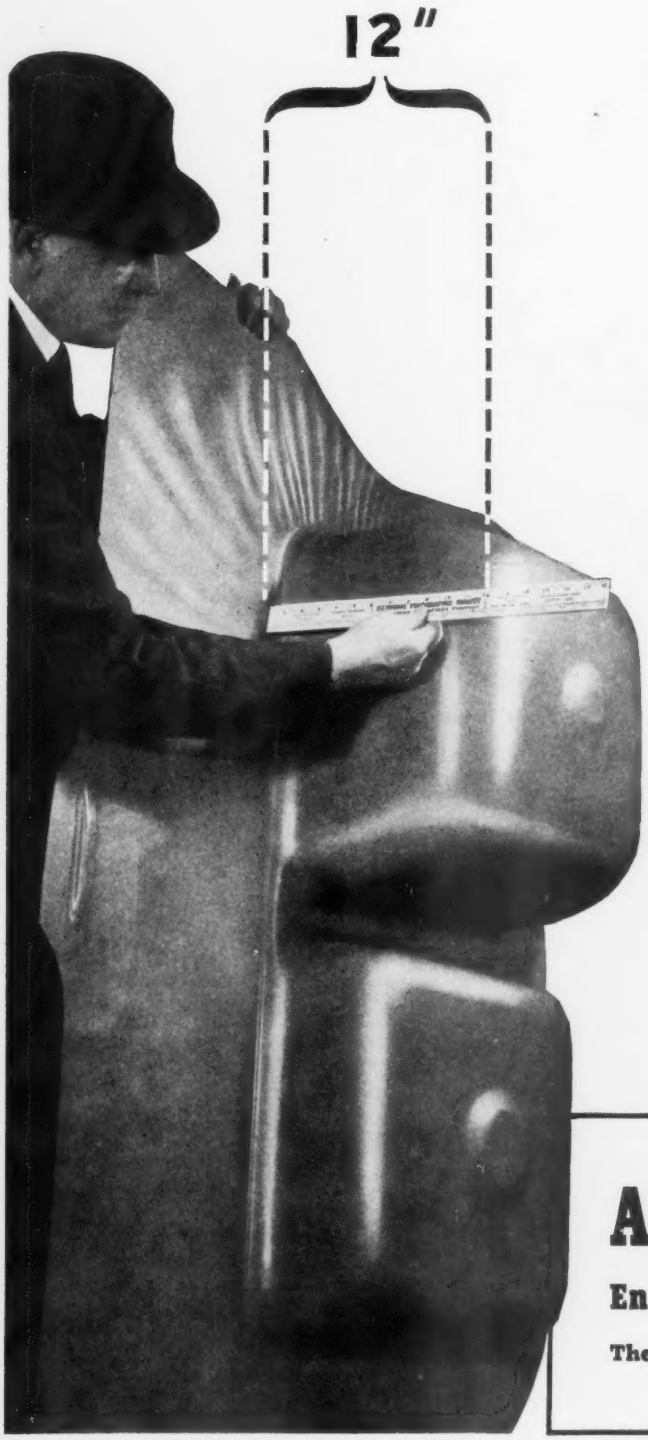

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ARMCO

Enameling Iron

The World's Standard

PORCELAIN ENAMEL ON ARMCO INGOT IRON

ALPHABETICAL LIST OF ADVERTISERS

	Page
American Potash & Chemical Corporation	36
American Rolling Mill Co	7
Bausch & Lomb Optical Co	23
Bethlehem Steel Co	23
Buyers' Guide	13–16
Carborundum Company	2
Celo Mines, Inc	*E155
Ceramic Color & Chemical Mfg. Company	30
Chicago Vitreous Enamel Product Company	10
Corhart Refractories Company	18
Denison Engineering Co	22
Denver Fire Clay Company	10
DeVilbiss Company	20
Drakenfeld, B. F., & Company	Inside Front Cover
Du Pont de Nemours, E. I., & Company	35
Electro Refractories & Alloys Corporation	28
Edward Orton, Jr., Ceramic Foundation	30
Eureka Flint & Spar Co	6
Exolon Company	36
Frazier-Simplex, Inc	19
Georgia Kaolin Co	17
Great Lakes Foundry Sand Co	21
Hammill & Gillespie, Inc	23
Hardinge Co., Inc	29
Harshaw Chemical Co	12
Hartford-Empire Company	30
Hommel, O., Company, Inc	33
Ingram-Richardson Mfg. Co. of Indiana, Inc	31
International Smelting & Refining Co	25
Jungmann & Co	26
Kentucky Clay Mining Company, Inc	27
Kentucky-Tennessee Clay Co	33
Lancaster Iron Works, Inc	3–4
Maxson, Elwyn L	25
McDanel Refractory Porcelain Company	36
Metakloth Company	33
Metal & Thermit Corporation	Outside Back Cover
Montgomery Porcelain Products Company	26
National Engineering Co	26
Norton Co	24
Old Hickory Clay Co	31
Orton, Edward, Jr., Ceramic Foundation	30
Pacific Coast Borax Company	37
Paper Makers Importing Company	9
Pennsylvania Salt Mfg. Co	11
Porcelain Enamel & Mfg. Company	37
Potters Supply Company	34
Proctor & Schwartz, Inc	22
Professional Directory	37
Pyrometer Instrument Co	34
Ransome Concrete Machinery Co	22
Roessler & Hasslacher Chemical Company	35
Society of Glass Technology	31
Solvay Sales Corporation	10
Spinks, H. C., Clay Company	Inside Back Cover
Star Stencil Works	26
Swindell-Dressler Corp	36
Taylor, Charles, Sons Co	38
Titanium Alloy Mfg. Co	32
United Clay Mines Corporation	5
Vitro Mfg. Company	25
Willson Products, Inc	34
Wilson, H. W., Company	37
Wyodak Chemical Co	22

* Page marked E appears in Editorial Section

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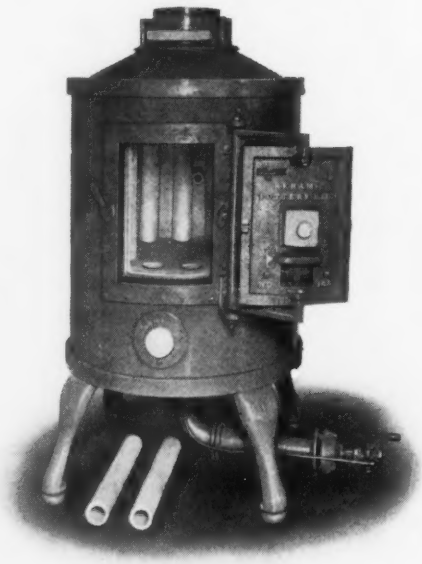

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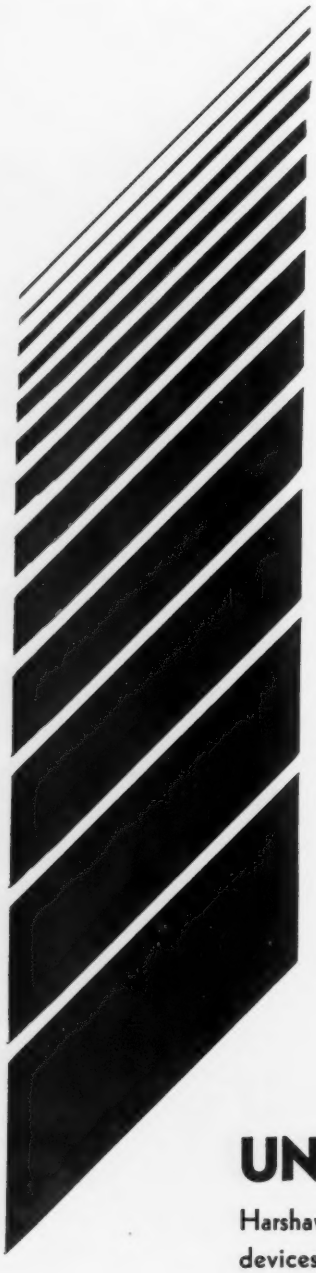

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The Hommel Co., O., Inc.
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The Vitro Mfg. Co.

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The Hommel Co., O., Inc.
The Vitro Mfg. Co.

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National Engineering Co.

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Electro Refractories & Alloys Corp.
Norton Co. (*Alundum-Crystolon*)

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Bichromate of Soda
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Bitstone
Potters Supply Co.

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Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.
The Vitro Mfg. Co.

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Bone Ash
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Borax
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Denver Fire Clay Co.
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Pacific Coast Borax Co.
The Vitro Mfg. Co.

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American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
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Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

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Denver Fire Clay Co.
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The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

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American Potash & Chemical Corp.
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Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pacific Coast Borax Co.
The Vitro Mfg. Co.

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Electro Refractories & Alloys Corp.
Norton Co.
The Vitro Mfg. Co.

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Harshaw Chemical Co.
The Hommel Co., O., Inc.

Carbofrax (Refractory Products)
Carborundum Co.

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Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
The Porcelain Enamel and Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Cerium Oxide
Drakenfeld, B. F., & Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Maxson, Elwyn L.
Old Hickory Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Bentonite)
Wyodak Chemical Co.

Clay (Block)
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Georgia Kaolin Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay—Cleaners, Feeders
Lancaster Iron Works, Inc.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Maxson, Elwyn L.
Old Hickory Clay Co.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Maxson, Elwyn L.
Metal & Thermit Corp.
Old Hickory Clay Co.
Paper Makers Importing Co.
The Porcelain Enamel & Mfg. Co.
Spinks, H. C., Clay Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay (Fire)
Denver Fire Clay Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Potters Supply Co.

Clay (German Vallendar)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.

The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Kentucky Clay Mining Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
United Clay Mines Corp.

Clay Miners
Maxson, Elwyn L.
Old Hickory Clay Co.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Potters)
Denver Fire Clay Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Old Hickory Clay Co.
Maxson, Elwyn L.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Process Equipment)
Hardinge Co.
Lancaster Iron Works, Inc.
National Engineering Co.

Clay (Sagger)
Georgia Kaolin Co.
The Hommel Co., O., Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Maxson, Elwyn L.
Old Hickory Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay-Slip (Albany)
Hammill & Gillespie, Inc.
United Clay Mines Corp.

Clay (Wad)
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Clay (Wall Tile)
Hammill & Gillespie, Inc.
Kentucky Clay Mining Co.
Kentucky-Tennessee Clay Co.
Maxson, Elwyn L.
Old Hickory Clay Co.
Paper Makers Importing Co.
Spinks, H. C., Clay Co.
United Clay Mines Corp.

Cleaners
Pennsylvania Salt Mfg. Co.
The Porcelain Enamel & Mfg. Co.

Cleaners, Chemical
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Clocks (Gauge Board)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Cobalt Sulphate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Colors
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Concrete (Chutes, Grouters)
Ransome Concrete Machinery Co.

Cones
The Edward Orton, Jr., Ceramic Foundation

Conveying Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
National Engineering Co.

Copper Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Corhart
Corhart Refractories Co.

Cornwall Stone (Imported)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Eureka Flint & Spar Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

Crucibles (Filter, Melting, Ignition)
Carborundum Co.
Denver Fire Clay Co.
Norton Co.
Potters Supply Co.

Crushers (Clay)
Lancaster Iron Works, Inc.

Cryolite (see Kryolith)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
The Vitro Mfg. Co.

Crystolon (Refractory Products)
Norton Co.

Cullet, Washing Plants, Incinerators, Crushers
Frazier-Simplex, Inc.

Cutters (Bar)
Ransome Concrete Machinery Co.

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Disintegrators
Hardinge Co.
Lancaster Iron Works, Inc.
National Engineering Co.

Dryer (Pipe Rack)
Lancaster Iron Works, Inc.

Drying Machinery
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Proctor & Schwartz, Inc.

Electrocast Refractories
Corhart Refractories Co.

Enameling Equipment (Complete)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

Enameling Furnaces
Carborundum Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Lancaster Iron Works, Inc.
Norton Co.

Enameling Iron (Sheet)
American Rolling Mill Co.
Bethlehem Steel Co.

Enameling Muffles
Bethlehem Steel Co.
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Electro Refractories & Alloys Corp.
Frazier-Simplex, Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Enamel Oxide
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Hardinge Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.

Exhaust Systems
The DeVilbiss Co.

Feldspar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Eureka Flint & Spar Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Filter Fabrics
Metakloth Company

Fire Brick
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Charles Taylor Sons Co.

Fire Brick—Process Equipment
Lancaster Iron Works, Inc.

Fire Clay
Denver Fire Clay Co.
Spinks, H. C., Clay Co.

Flint
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Porcelain Enamel & Mfg. Co.

Flint Pebbles
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Eureka Flint & Spar Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Vitro Mfg. Co.

Floors (Non-Slip)
Norton Co.

Fluorspar
Harshaw Chemical Co.
The Hommel Co., O., Inc.

French Flint
Eureka Flint & Spar Co.
Maxson, Elwyn L.
Paper Makers Importing Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Frosting Mixtures
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Fuel Oil Systems and Control, Stokers
Bethlehem Steel Co.
Frazier-Simplex, Inc.

Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Swindell-Dressler Corp.

Furnaces, Enameling
Swindell-Dressler Corp.

Glass Bending Ovens, Glass Decorating Machines
Frazier-Simplex, Inc.

Glass Equipment
Hartford-Empire Co.
Lancaster Iron Works, Inc.

Glass Melting Tanks and Furnaces
Frazier-Simplex, Inc.

Glass Thickness Gauge
Bausch & Lomb Optical Co.

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Eureka Flint & Spar Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Eureka Flint & Spar Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.

Goggles
The Hommel Co., O., Inc.
Willson Products, Inc.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Gold Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Granulators
Hardinge Co.
Lancaster Iron Works, Inc.

Grinding Wheels
Carborundum Co. (*Carborundum and Aloxite*)
Chicago Vitreous Enamel Product Co.
Norton Co. (*Alundum-Crystolon*)

Hearths
Carborundum Co. (*Carbofrax* heat treating)
Corhart Refractories Co.
Electro Refractories & Alloys Corp.
Norton Co. (*Crystolon*)

Hearths (Fused Al_2O_3, SiC)
Electro Refractories & Alloys Corp.

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

Hoppers (Floor, Tower)
Ransome Concrete Machinery Co.

Hose (Air and Fluid)
The DeVilbiss Co.

Hydraulic Propellers
Denison Engineering Co.

Hydrofluoric Acid
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Iron Chromite
Harshaw Chemical Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
United Clay Mines Corp.
The Vitro Mfg. Co.

Kellog AA Refractories
Electro Refractories & Alloys Corp.

Kilns, China (Decorating)
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Frazier-Simplex, Inc.
The Hommel Co., O., Inc.
Swindell-Dressler Corp.

Kilns- (Electric, Circular, Tunnel)
Swindell-Dressler Corp.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide) (Refractory)
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
(P. B. Sillimanite) Charles Taylor Sons Co.

Kyanite
Celo Mines, Inc.

Kryolith (see Cryolite)
Pennsylvania Salt Mfg. Co.

Laboratory Ware
Norton Co.

Lehr Tile (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Electro Refractories & Alloys Corp.

Lehrs
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehrs (Electric or Fuel Heated)
Frazier-Simplex, Inc.
Swindell-Dressler Corp.

Lehr Loaders
Frazier-Simplex, Inc.

Linings (Furnace Refractory, Block Refractory Plate, Brick, and Tile)
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.
(P. B. Sillimanite) Charles Taylor Sons Co.
The Vitro Mfg. Co.

Lithium Carbonate
Drakenfeld, B. F., & Co.

Loaders (Bucket)
National Engineering Co.

Magnesia (Fused)
Electro Refractories & Alloys Corp.
Norton Co.

Magnesia (Sintered, Calcined)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Magnesite Calcined
The Hommel Co., O., Inc.

Magnesium Carbonate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Manganese Dioxide
Drakenfeld, B. F., & Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Masks (Breathing)
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Microscopes (Polarizing)
Bausch & Lomb Optical Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Mixers
National Engineering Co.
Ransome Concrete Machinery Co.

Mixers (Batch)
Lancaster Iron Works, Inc.
National Engineering Co.

Mixers (Concrete, Paving, Road Paving, Plaster, Asphalt, Truck, Mortar, Bituminous)
Ransome Concrete Machinery Co.

Mixers (Laboratory)
National Engineering Co.

Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Frazier-Simplex, Inc
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.

Muffles (Laboratory)
Electro Refractories & Alloys Corp.

Mullers (Batch)
National Engineering Co.

Mullite (Refractories)
Electro Refractories & Alloys Corp.

Muriatic Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.

Needle Antimony
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nickle Salts
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Nitre
Harshaw Chemical Co.
The Hommel Co., O., Inc.

Non-Gro Refractories
Electro Refractories & Alloys Corp.

Norbide (Norton Boron Carbide)
Norton Co.

Olivine
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Overglaze Colors
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Palladium Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Pins
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Louthan Mfg. Co.
Potters Supply Co.

Pins (Tile Setter)
Louthan Mfg. Co.

Placers (Concrete Pneumatic)
Ransome Concrete Machinery Co.

Platinum Decorations
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.

Polariscopes
Bausch & Lomb Optical Co.
Frazier-Simplex, Inc.

Porcelain Enameling Service (Practical)
American Rolling Mill Co.
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Hardinge Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Ingram-Richardson Mfg. Co. of Indiana Inc.
The Hommel Co., O., Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.

Potters Wheels
Denver Fire Clay Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc. R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Solvay Sales Corp.
The Vitro Mfg. Co.

Producer Glass Plants
Frazier-Simplex, Inc

Pug Mills
Lancaster Iron Works, Inc.
Pyrites (Natural Iron Sulphide)
The Hommel Co., O., Inc.
Pyrometer Tubes
Carborundum Co.
Electro Refractories & Alloys Corp.
Montgomery Porcelain Products Co.
Pyrometer Tubes (Refractory and Hard Porcelain)
Denver Fire Clay Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.
Pyrometers (Optical, Radiation, Surface, Immersion, Needle)
Pyrometer Instrument Co.
Pyrometric Cones
The Edward Orton, Jr., Ceramic Foundation
Racks, Firing (Refractory)
Louthan Mfg. Co.
Raw Material Handling Equipment
Frazier-Simplex, Inc.
Lancaster Iron Works, Inc.
Refractometers
Bausch & Lomb Optical Co.
Refractories
Carborundum Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.
(P. B. Sillimanite) Charles Taylor Sons Co.
Refractory Materials
Carborundum Co.
Chicago Vitreous Enamel Product Co.
Corhart Refractories Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Louthan Mfg. Co.
Norton Co.
Titanium Alloy & Mfg. Co.
Represses (Automatic)
Lancaster Iron Works, Inc.
Respirators
Chicago Vitreous Enamel Product Co.
The DeVilbiss Co.
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
Willson Products, Inc.
Rutile
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal and Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Potters Supply Co.
Charles Taylor Sons Co.
Salt Cake
American Potash & Chemical Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Sandblast Helmets
Willson Products Inc.
Sand Grinder and Sifters
Lancaster Iron Works, Inc.
Saponin
The Hommel Co., O., Inc.
Screening and Magnetic Separators
National Engineering Co.
Selenite of Sodium
Drakenfeld, B. F., & Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.
Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.
Setters (Tableware)
Louthan Mfg. Co.
Sheaves (Tower)
Ransome Concrete Machinery Co.
Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.
Silica (Fused)
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.
Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Harshaw Chemical Co.
Silicon Carbide
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Silicon Carbide Firesand
Carborundum Co.
Sillimanite, P. B.
Charles Taylor Sons Co.
Sillimanite Refractories
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Slab Pushers—Hydraulic
Denison Engineering Co.
Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Norton Co.
Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Solvay Sales Corp.
The Vitro Mfg. Co.
Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.
Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.
Sodium Metasilicate
Harshaw Chemical Co.
Sodium Nitrite
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Sodium Silica Fluoride
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Sodium Uranate
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Soot Blowers
Frazier-Simplex, Inc.
Special Machines
Frazier-Simplex, Inc.
Spar
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Eureka Flint & Spar Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Maxson, Elwyn L.
Paper Makers Importing Co.
The Vitro Mfg. Co.
Spray Booths
The DeVilbiss Co.
The Hommel Co., O., Inc.
Spraying Equipment
The DeVilbiss Co.
The Hommel Co., O., Inc.
Spurs
Louthan Mfg. Co.
Potters Supply Co.
Stacks
Lancaster Iron Works, Inc.
Steel Plate Construction
Bethlehem Steel Co.
Lancaster Iron Works, Inc.
Stilts
The Hommel Co., O., Inc.
Louthan Mfg. Co.
Potters Supply Co.
Sulfuric Acid
Denver Fire Clay Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Pennsylvania Salt Mfg. Co.
Talc
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
Tanks
Frazier-Simplex, Inc.
Tank Blocks
Corhart Refractories Co.
Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.
Tile (Floor)
Norton Co.
Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Tile Setter Pins
Louthan Mfg. Co.
Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
(P. B. Sillimanite) Charles Taylor Sons Co.
Tile (Wall)
Denver Fire Clay Co.
Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Vitro Mfg. Co.
Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
Towers (Concrete, Concrete Elevating, Steel Elevating)
Ransome Concrete Machinery Co.
Tri Sodium Phosphate
Harshaw Chemical Co.
Trucks
Lancaster Iron Works, Inc.
Tubes (Insulating)
Carborundum Co.
Louthan Mfg. Co.
McDanel Refractory Porcelain Co.
Norton Co.
Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.
Norton Co.
Uranium Oxide
Drakenfeld, B. F., & Co.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Uranium Oxide (Yellow-Orange-Black)
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.
Water Softening Plants
Frazier-Simplex, Inc.
Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana,, Inc.
The Porcelain Enamel & Mfg. Co.
Titanium Alloy & Mfg. Co.
The Vitro Mfg. Co.
Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld, B. F., & Co.
Du Pont de Nemours, E. I., & Co., Inc , R. & H. Chemicals Dept.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.
Winding Drums
Lancaster Iron Works, Inc.
Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.
Zircon
The Hommel Co., O., Inc.
Zirconia
Ceramic Color & Chemical Mfg. Co.
Du Pont de Nemours, E. I., & Co., Inc., R. & H. Chemicals Dept.
Harshaw Chemical Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
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FORTY-FIRST ANNUAL MEETING, AMERICAN CERAMIC SOCIETY

MEETING SCHEDULES AND DIRECTORY

General Sessions: North Ball Room
Art Division: Room 430A (see also programs for special meetings outside of Hotel)
Enamel Division: South Ball Room
Glass Division: North Ball Room
Materials and Equipment Division: P.D.R. No. 1
Refractories Division: North Assembly Room
Structural Clay Products Division: P.D.R. No. 2
White Wares Division: West Ball Room
Board of Trustees: P.D.R. No. 4
Local Committees: P.D.R. No. 412
Editorial and Press Room: P.D.R. Nos. 5 and 6
Student Headquarters: P.D.R. No. 451
Ceramic Educational Council: P.D.R. No. 2
Fellows: North Assembly Room
Institute of Ceramic Engineers: P.D.R. No. 2
Ceramic Camera Club: Room 421A

Program Outline Schedule—April 16–22, 1939

Hotel Stevens—Chicago, Illinois

	Sunday April 16	Monday April 17	Tuesday April 18	Wednesday April 19	Thursday April 20	Friday and Saturday April 21–22
Breakfast	Note: P.D.R. (private dining room)	7:30 A.M. Editorial Committees and Abstracters	7:30 A.M. Trustees and Standing Committes	7:30 A.M. Division and Section Officers		
Morning	All week Board of Trustees—P. D. R. No. 4 Local Committees—P.D.R. No. 412 Press Room—P.D.R. Nos. 5 and 6 Student Headquarters—P.D.R. No. 451	9:00 A.M. General Session—Symposium: "Importance of Thermal History," led by G. A. Bole—North Ball Room	9:00 A.M.–12:00 M. Division Meetings Art—Room 430A (see Program for special meetings) Enamel— South Ball Room Glass—North Ball Room Materials and Equipment—P.D.R. No. 1 Refractories—North Assembly Room Structural Clay Products—P.D.R. No. 2 White Wares—West Ball Room		9:00 A.M. General Session—Symposium: "Glaze and Enamel Properties"—North Ball Room Round Table Discussion of Methods of Analysis of Silicates—South Ball Room	Plant trips
Noon	Ceramic Educational Council	Board of Trustees—P.D.R. No. 4	Editorial Committees and Abstracters	Divisions and Sections	Board of Trustees—P.D.R. No. 4	
Afternoon	2:00–4:00 P.M. Ceramic Educational Council—P.D.R. No. 2 4:00–6:00 P.M. Fellows Meeting—North Assembly 6:00–8:00 P.M. Keramos Dinner Meeting—South Ball Room	2:00 P.M. General Session—Symposium: "Glaze and Enamel Properties," led by F. H. Norton—North Ball Room	2:00–5:00 P.M Division Meetings		Plant trips	Plant trips
Night	8:00 P.M. Edward Orton, Jr., Memorial Fellow Lecture—Grand Ball Room	6:00 P.M. College Alumni Dinners 9:00 P.M. Student Reception—Boulevard Room	7:00 P.M. Dinner Dance Entertainment—Grand Ball Room	7:00 P.M. Institute of Ceramic Engineers—P.D.R. No. 2		

All week: Ceramic Camera Club—Room 421A

CHICAGO LOCAL COMMITTEES

Executive

Frank E. Hodek, Jr., *Chairman;* E. C. Aydelott and A. L. Vodicka, *Vice-Chairmen;* Rex Newcomb, Jr., *Secretary;* A. I. Andrews, Wm. Hoganson, Rudyard Porter, Fred L. Steinhoff

General

George Arras, J. A. Dedouch, Hugo Filippi, Walter Gavin, F. A. Guignon, George Hanson, G. G. Kent, W. C. Lindemann, M. E. Manson, R. S. Olson, Robert Onan, Howard Parman, C. W. Parmelee, Frank Porter, Burnett Purcell, B. S. Radcliffe, Thomas Rogers, Kenneth Strong, Bert Sweely, J. C. Vollrath

Publicity

Edward Goetz, *Chairman;* H. Dana Chase and Rex Newcomb, Jr.

Entertainment

R. A. Beverley, *Chairman;* Fred Buck, Bart Fennessy, C. L. Frederick, Jr., Richard Goble, H. J. Shaner, Bruce Wagner, D. B. Walters, E. W. Woodruff

Plant Visitation

March Nagle, *Chairman;* E. R. Brauner, J. A. DeCelle, E. H. Haeger, Carl E. Lyon, Howard Parman, L. I. Shaw

Transportation

George G. Hanson, *Chairman;* Roger Fellows and John T. Roberts

Women

Mrs. Myrtle French, *Chairman;* Mrs. A. I. Andrews, Mrs. Edward Goetz, Mrs. R. S. Olson, Mrs. Rudyard Porter, Mrs. J. T. Roberts

EDWARD ORTON, JR., FELLOW MEMORIAL LECTURE

Hotel Stevens: Grand Ball Room

Sunday Night, April 16, 1939: 8:00 P.M.

Members and General Public Invited

Paul E. Cox, Dean of Fellows, *Presiding Officer*

Subject: A Background for Ceramics
By Lawrence E. Barringer: General Electric Co., Schenectady, N. Y.

DATA ON ACTIVITIES OF MR. BARRINGER

Education

Graduated: Washington, D. C., High School, 1894, and Ohio State University (E.M. in Ceramics), 1902; Ohio State University (Ceramic Engineer's Degree), 1933.

Positions

E. M. Freese & Co., Galion, Ohio (brick machinery manufacturers), 1895–1896; shop student: American Terra Cotta Co., Crystal Lake, Ill., 1898; chemist: Columbus Brick & Terra Cotta Co., Union Furnace, Ohio, 1900–1901; entered employ as ceramic specialist: General Electric Co., Schenectady, N. Y., 1902, and engineer of insulations, Oct. 23, 1908; Director: Locke Insulator Corp., Baltimore, Md., and Monowatt Electric Corp., Providence, R. I.

American Ceramic Society Service

Member, 1905; President, 1916; Chairman, Committee on Publications (starting *Journal*), 1918–1920; Chairman, Committee on Rules, 1924–1930; Fellow, 1930; Chairman, Art Division, 1933–1936; Dean of Fellows, 1933; and Trustee, Art Division, 1937–.

Fraternities

Phi Delta Theta (Ohio Zeta), 1898; Tau Beta Pi (Ohio Gamma), 1931.

U. S. Patents

Granted twenty-five U. S. Patents, covering insulating and ceramic compositions.

Honors

Awarded Silver Medal by Panama-Pacific Exposition, 1915.

Civic Offices

Member, Board of Education, Schenectady, N. Y., March 5, 1918 to May, 1929; President of Board, May, 1922 to May, 1929.

Clubs and Societies

American Ceramic Society; American Society for Testing Materials; Chemists Club (New York); Mohawk Golf Club (Schenectady, N. Y.); New York Society of Ceramic Arts (*president*); Arts; Ceramic Association of New Jersey; Ceramic Association of New York; Ceramic Society of England.

Publications

Transactions of the American Ceramic Society

"Relation between Constitution of a Clay and Its Ability to Take a Good Salt Glaze," **4,** 211 (1902).
"Note on Vapor Glazing," **5,** 105 (1903).
"Method for Making Enameled Brick," **5,** 256 (1903).
"Influence of Magnesia on Clay," **6,** 86 (1904).
"Note on Black Speckle for Use on Red Face Brick," **6,** 198 (1904).
"Construction of a Whiteware Pottery," **6,** 203 (1904).
"Strength of Sagger Bodies," **7,** 201 (1905).
"Measurement of Settle in Brick Kilns," **7,** 409 (1905).
"Hydrous Silicates Formed under Steam Pressure," **15,** 125 (1913).
"A Continuously Operated Tunnel Kiln for High-Grade Clay Ware," **18,** 106 (1916).
"Presidential Address," **19,** 69 (1917).

Journal of the American Ceramic Society

"Comparative Value of Kneading and Pugging in Preparation of Porcelain Bodies," **2,** 306 (1919) (in coöperation with C. E. Treischel).
"Application of Electric Heat to Vitreous Enameling," **4,** 461 (1921).

General Electric Review

"Porcelain for Electrical Purposes," **10** [4] 160 (1908).
"Importance of Standards in Evaluation of Insulating Materials," **27** [11] 736 (1924).
"Revolutionary Development in Mica Insulation," **29** [11] 757 (1926).
"Molded Insulation," **30** [8] 387 (1927).
"Glyptal Mica Moves Ahead—Now the Flexible Form," **32** [10] 530 (1929).
"Glyptal Lacquers," **32** [12] 660 (1929).
"Mycalex, a Molding Material with Unique Properties," **34** [7] 406 (1931).
"Glyptal in the Foundry," **34** [12] 736 (1931).
"Far-Flung Foes of Insulation," **37** [11] 498–503 (1934).
"Porcelain and Porosity," **38** [7] 308–11 (1935).
"Present Status of Synthetic Resins in Electrical Field," **40** [12] (1937).

Wisconsin Engineer

(Published by Univ. of Wisconsin, Madison, Wis.).
"Importance of Insulation in Electrical Engineering," **29** [7] 130 (April, 1925).

Transactions of the Electrochemical Society

"Relation of Chemical and Physical Structure to Dielectric Behavior," **65,** 27–34 (1934).

Proceedings A.S.T.M.

"Significance of Material Tests and of Design Tests upon Electrical Insulating Materials," Vol. 36, Part II (1936).

International Congress, International Assn. for Testing Materials, London, April 19–24, 1937.

"Testing of Electrical Porcelain."

GENERAL SESSION SYMPOSIUM ON IMPORTANCE OF THERMAL HISTORY

Chairman: G. A. Bole, Edward Orton, Jr., Ceramic Foundation, Columbus, Ohio

Hotel Stevens: North Ball Room

Monday Forenoon, April 17, 1939: 9:00 A.M.–12:00 M.

Presidential Address by Victor V. Kelsey: Dominion Minerals, Inc., Washington, D. C.

1. Discussion on Problem of Firing Ceramic Ware

By Philip Dressler: Swindell-Dressler Corp., Pittsburgh, Pa.

From the earliest days, the builder of tunnel kilns has faced the dual problems of securing control of the heat distribution from end to end of the kiln and also through its cross section. Lack of this control has prevented the realization of maximum speed and uniformity of firing, which the tunnel kiln theoretically should produce. Recent developments have finally solved simultaneously these two interrelated problems. The methods used to achieve the desired results are discussed.

2. Methods of Achieving Uniform Firing of Clayware

By J. L. Carruthers: Dept. of Ceramic Engineering, Ohio State Univ., Columbus, Ohio

A discussion will be presented as follows: (*a*) deficiencies observed in firing various ware in different types of kilns; (*b*) methods of controlling and measuring heat distribution in such kilns; (*c*) economy factors involved in such methods; and (*d*) the suitability of pyrometric cones to achieve uniform heat distribution and uniform firing.

3. Thermal History of Glass and Its Effect upon Physical Properties

By Woldemar A. Weyl: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

It is well understood that physical and chemical properties of ceramic ware, such as refractories, whiteware, and glazes, must depend upon the firing schedule and the rate of cooling. In these cases, systems are dealt with which react toward a certain equilibrium, usually without reaching it under technical conditions. When the ware is drawn from the furnace, the reactions will be arrested and a nonequilibrium state will be frozen in, which determines the properties of the product.

Glasses, on the other hand, have reached such a degree of homogeneity in the molten state that prolonged heating at these temperatures can not affect their properties materially unless the composition should change due to volatilization of some constituents or as a result of refractory attack. The rate of cooling, however, is of considerable influence on the properties of the resulting glasses.

To understand this influence of thermal history on properties of glass, two kinds of reactions are assumed to be going on in a glass when it is cooled. One kind responds practically instantaneously to temperature changes, whereas the other requires time. The sluggish changes, which are due to atomic rearrangements, can be easily frozen in when the viscosity becomes high enough. The influence of the rate of cooling on some properties will be discussed and some technical applications mentioned.

4. Effect of Thermal History on the Residual Strains in, and Resultant Properties of, Enamelware

By W. N. Harrison: National Bureau of Standards, Washington, D. C.

Experimental results will be presented, which follow through the development of strains in enameled iron articles as they are cooled after firing and which show how changes in cooling schedule can strongly influence the magnitude of the residual strains. The effect of the residual strains on the resistance of enamelware to several types of failure will be discussed.

5. Effect of Thermal History on Physical Properties of Electrical Porcelain

By E. H. Fritz: Westinghouse Electric & Mfg. Co., Derry, Pa.; and H. C. Harrison: Research Lab., Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

A brief review of the firing requirements of electrical porcelain will be presented. Some factors are traced in the relation of body composition, the thermal history, and the coefficient of thermal expansion of the fired body with its resultant effect upon the modulus of rupture of the glazed body.

6. Properties of Ware versus Thermal History

By J. H. Koenig: Hall China Co., East Liverpool, Ohio

Properties of ware receiving different thermal treatments were compared, and the microstructure of the body, glaze microtexture, and the glaze-body interface were examined. The tests on semivitreous and vitreous body specimens fired differently include shrinkage, flexural strength, elasticity, thermal expansion, etc.

7. Thermal Control in Relation to the Esthetic History of Ceramics

By R. Guy Cowan: Onondaga Pottery Co., Syracuse, N. Y.

A historical sketch will be presented of the results attained by various civilizations as their ability to build kilns and to control temperature and atmosphere continued to increase. The subject is to be treated from the esthetic viewpoint.

8. Discussion of Structural Clay Products

By Ralston Russell, Jr.: Engineering Expt. Station, Ohio State Univ., Columbus, Ohio

The discussion includes (1) the firing and cooling treatment of structural clay products, its relation to the physical properties of the ware, and its effect upon the ability of the ware to withstand service conditions; (2) the relation of thermal history to deterioration of the fired product; and (3) a consideration of present practice and the possibilities of varying the thermal treatment to reduce losses and to improve quality.

9. Discussion on Terra Cotta

By D. F. Albery: Charleston Vitreous Clay Products Co., Charleston, W. Va.

The effects of firing temperature, rate of firing and cooling, and combustion gases in periodic and tunnel kilns on crazing, cracking, discoloration, spalling, and disintegration of terra cotta are presented. The firing temperature and schedule and their effect on the satisfactory production of gold and platinum finishes on terra cotta are also discussed.

GENERAL SESSION SYMPOSIUM ON GLAZE PROPERTIES

Chairman: F. H. Norton, Massachusetts Institute of Technology, Cambridge, Mass.

Hotel Stevens: North Ball Room

Monday Afternoon, April 17, 1939: 2:00 P.M.–5:00 P.M.

Suggested Agenda of Topics

I. Chemical Classification

II. Properties of the glaze slip and application
- (*A*) The slip
  - (1) fineness
  - (2) suspending agents (see No. 1 Program title)
  - (3) deflocculating agents
  - (4) specific gravity and viscosity
- (*B*) Application
  - (1) types of ware
  - (2) dipping
  - (3) spraying

III. Drying Properties
- (*A*) Shrinkage
  - (1) crawling
- (*B*) Adherence
  - (1) clays
  - (2) organic agents
- (*C*) Drying temperatures

IV. Firing Properties
- (*A*) Prefusion
  - (1) softening of frit
  - (2) breakup of carbonates
  - (3) oxidation of organic matter
  - (4) solid reactions
  - (5) shrinkage
- (*B*) Fusion
  - (1) fusion of frit
  - (2) reactions to form glass
  - (3) bubbles (source)
  - (4) elimination of bubbles
  - (5) glaze-body reaction (see No. 2 Program title)
  - (6) flowing (viscosity)
  - (7) surface smoothness
  - (8) volatilization (see No. 6 Program title)
  - (9) surface tension and wetting ability
- (*C*) Cooling
  - (1) contraction curve of glaze (see No. 7 Program title)
  - (2) contraction curve of body
  - (3) stress in glaze (see No. 8 Program title)
  - (4) setting temperature of glaze
  - (5) crystallization

V. Aging Properties
- (*A*) After-contraction
  - (1) stress developed (see No. 3 Program title)
  - (2) time for aging and temperature
- (*B*) Moisture expansion
  - (1) glaze
  - (2) body

VI. Permanent Physical Properties
- (*A*) Texture of surface
- (*B*) Opacity
- (*C*) Color (reaction with over- and under-glaze colors) (see Nos. 8 and 9 Program titles)
- (*D*) Index of refraction
- (*E*) Hardness (see No. 4 Program title)
- (*F*) Impact resistance
- (*G*) Resistance to chemical attack (see No. 5 Program title)
- (*H*) Influence on properties of body

1. Unit Clay as Aid to Glaze Slip Control

By C. G. Harman: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

Suggestions are made of a rational conception of the introduction and functions of suspending and "setting-up" agents in slips (outline No. II (*A*) (2)).

2. Promotion of Interfacial Reactions to Counteract Crazing

By R. M. Campbell: Dept. of Ceramic Technology, N. Y. State College of Ceramics, Alfred, N. Y.

Thin mineral layers were applied to biscuit vitreous and semivitreous whiteware bodies. The layers were subsequently coated with a glaze and fired at a glost temperature. In certain cases, a better glaze texture has been obtained as well as increased resistance to crazing (outline No. IV (*B*) (5)).

3. Comparison of Glaze-Fit Test Methods for Semivitreous Bodies

By W. C. Bell: Engineering Expt Station, Ohio State Univ., Columbus, Ohio

The results of the ring, flat-plate, and tuning-fork tests on semivitreous bodies and glazes are compared (outline No. V (*A*) (1)).

4. Discussion of Methods of Measuring Glaze Hardness

By F. P. Hall: Onondaga Pottery Co., Syracuse, N. Y.

This discussion will include (*a*) impact resistance of glazes and (*b*) scratch hardness as measured by various instruments (outline No. VI (*E*)).

5. Solubility of Colored Glazes in Organic Acids

By R. F. Geller and A. S. Creamer: Whiteware Section, National Bureau of Standards, Washington, D. C. (Published *Jour. Amer. Ceram. Soc.*, **22** [4] 133–40 (1939).)

The purpose of this study was to determine primarily which, if any, of the glazes tested constituted a health hazard because of lead or other toxic oxides which might be dissolved from them; and, secondarily, to develop suitable test procedures for future control work. A conference of representatives of the U. S. Potters Association, the Food and Drug Administration of the Department of Agriculture, and the National Bureau of Standards was held, and a series of accelerated and simulative service tests was outlined. These tests were made on specimens from six coöperating manufacturers. It is shown that the lead extracted by pouring hot, distilled vinegar (5% acetic acid) or a 0.5% solution of citric acid in a cup and by leaving it to cool in contact with the glaze for $^1/_2$ hr. would be as much, or more, than the lead normally extracted by jams and fruit juices. With the same or a similar test procedure, a citric-acid solution of 10% strength may be required to indicate how much lead might be taken up by lemonade or vinegar. The results also indicate that glazes of one color only, among those tested, constitute a probable health hazard. Two other glazes from one manufacturer, however, were found to be marginal, and a third may cause trouble if indicated corrective measures, such as a preliminary acid wash, should be neglected by the manufacturer (outline VI (*G*)).

Note: This General Session will be concluded Thursday Forenoon, April 20 at 9:00 A.M.

General Session Symposium on Glaze Properties (continued)

Hotel Stevens: North Ball Room

Thursday Forenoon, April 20, 1939: 9:30 A.M.–12:00 M.

6. Use of the Spectrograph in a Preliminary Investigation of Volatile Constituents of Some Glazes

By H. C. Harrison, W. G. Lawrence, and D. J. Tucker: Dept. of Chemistry, N. Y. State College of Ceramics, Alfred, N. Y.

In the investigation, acidic, basic, amphoteric, and neutral ceramic mediums were studied to determine a suitable collector of the volitants. A study was also made to determine the temperatures at which the ingredients started to volatilize and the order in which they left the parent glaze. The investigation shows the value of the spectrograph in detecting minute quantities of volatile and nonvolatile glaze constituents (outline No. IV (*B*) (8)).

7. Elimination of Crazing in Sanitary Glazes by a Quick, Inexpensive Study of Coefficent of Expansion

By A. O. Knecht: Universal Sanitary Mfg. Co., Camden, N. J.

A brief history is given of glaze literature on coefficient of expansion, along with a short description of methods of determination. Using the factors of Mayer and Havas for calculating the coefficient of expansion of glazes from the percentage weights of their oxides, factors were calculated for glaze raw materials. Instead of using empirical formulas for raw materials, chemical analyses supplied by dealers of glaze materials were used. A series of glazes, starting with a high coefficient and gradually decreasing in coefficient, was tested. After determining from this series the calculated coefficient of the noncrazing glaze, a series was made varying the composition but keeping the coefficient constant. It was found that glazes of low coefficient would not craze. No crazing resulted on varying the composition of the glazes when the calculated coefficient was kept constant.

This method is a valuable means of controlling crazing in sanitary glazes because of its simplicity, the inexpensiveness of experimental equipment, and the relatively short time required for completing tests (outline No. IV (*C*) (1)).

8. Stresses in Electrical Porcelain Glazes

By Andrew L. Johnson: Ceramic Div., Metallurgy Dept., Massachusetts Inst. of Technology, Cambridge, Mass.

The stresses in electrical porcelain glazes have been studied by the modified Stieger method used by Blakely. Variations in composition over a considerable range show varying degrees of compression in the finished glaze but, compared with earthenware bodies, tensile stresses are much more difficult to obtain, which accounts for the comparative freedom of crazing in this type of ware (outline No. IV (*C*) (3)).

9. Effect of Various Zinc Compounds on Colors Produced in a Colored Glaze

By C. J. Kinzie and C. H. Commons, Jr.: Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

The effect of free zinc oxide *vs.* compounds, such as zinc zirconium silicate, zirconium spinel, etc., on greens, reds, pinks, etc., as produced in an otherwise zinc-free glaze, is discussed (outline No. VI (*C*)).

10. Discussion on Colored Glazes for Semiporcelain Dinnerware

By W. E. Dougherty: O. Hommel Co., Pittsburgh, Pa.

Types of glaze stains used in the preparation of various colored glazes for semiporcelain dinnerware are discussed and suggestions are given for the control necessary in the manufacture of such ware (outline No. VI (*C*)).

BALOPTICON PROJECTION LANTERN EQUIPMENT

The lanterns and projectors used in the technical sessions at this Meeting have been rented from the Bausch & Lomb Optical Company, Rochester, N. Y.

BAUSCH & LOMB EXHIBIT

The Bausch & Lomb Optical Company exhibit will be located in Private Dining Room No. 8. Members of the Society are urged to visit this educational exhibit. Representatives of the Company will be in attendance daily during the Meeting.

ART DIVISION PROGRAM

Chairman: A. E. Baggs, Dept. of Fine Arts, Ohio State Univ., Columbus, Ohio
Secretary: C. C. Engle, United Clay Mines Corp., Trenton, N. J.
Program Committee: L. E. Barringer, *Chairman*; General Electric Co., Schenectady, N. Y.; F. H. Rhead, Homer Laughlin China Co., Newell, W. Va.; H. R. Bacher, Rock Tavern, N. Y.
Program arranged by Myrtle M. French: Art Institute of Chicago, Chicago, Ill.

Hotel Stevens: Private Dining Room 430A

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–12:00 M.

1. Decorative Process Course for Ceramic Art Schools

By Frederick H. Rhead: Homer Laughlin China Co., Newell, W. Va.

2. Problems of Designing for Industry

By Edward Enthof, Crane Co., Chicago, Ill.

A discussion of the problems a designer encounters when he designs for mass production.

3. National Youth Administration in Ceramic Art

By Vera Odeyne Neff: 11312 Hessler Rd., Cleveland, Ohio

The purposes of the National Youth Administration ceramic art project in Cleveland, Ohio, are described. A brief history of the project is given together with suggestions for further development. Illustrations of actual work performed by students are given showing the degree of perfection actually attained by the youths.

4. Industrial Color Tolerances

By Isay A. Balinkin: University of Cincinnati and Cambridge Tile Mfg. Co., Cincinnati, Ohio

The possibility of establishing object-color tolerances upon a firm scientific basis leads to two requirements, *viz.*, (1) physical measurement of color and its evaluation as a numerical quantity, and (2) establishment of correlation between color differences expressed physically and visual perception of such color differences. The development of physical instruments for measuring color and adoption of standard illuminants, normal observer, and standard coordinate system by I.C.I. gave the necessary essentials to satisfy the first requirement. The second requirement is still in the process of development and a brief reference will be made to several methods proposed for evaluating color differences. The degree of agreement between computed color differences and color differences individually estimated by more than 60 observers on five different colored tile will be presented in a graphical form. The color difference between two arbitrarily chosen tile was designated by unity, and estimates were given on the ratio of the other nine color differences to this unit. From the standpoint of industrial color tolerances, this method of establishing the validity of any proposed equation for computing color difference seems to be direct and most valuable. For the past several months, many color measurements were made on Hunter's multipurpose reflectometer, and color differences computed with the use of Judd's equation on the basis of transformations referred to the uniform-chromaticity-scale triangle. In all future discussions the unit of color difference as evaluated from Judd's equation will be referred to as "judd." The following two manufacturing problems will be presented and discussed: (1) establishment of acceptable color tolerance, and (2) industrial control of color uniformity within that tolerance. The numerical magnitude of maximum acceptable color difference within a single article or between separate articles must depend upon the specific use of that article in actual service. It is, therefore, futile to expect that a single color tolerance could ever be established. Within a specific industry or in related fields, definite color tolerances could be adopted to a great profit both to the producer as well as the consumer. The most direct approach to the question of what the color tolerances should be is to present to the consumer several exhibits simulating the actual conditions of use. Each exhibit will represent a certain variation in color within determinable limits. The consumer is then to be asked to express his view on what he considers to be the maximum acceptable color tolerance. This procedure may not be simple, inasmuch as the cost per article is frequently connected with the magnitude of maximum allowable color tolerance. As an experiment, in the manufacture of ceramic wall tile, five different panels will be shown in which the maximum color variation from the standard tile is made on the basis of 1, 2, 3, 4, and 5 judds. The audience will be asked to examine these panels and express their opinion on what they consider to be an acceptable color tolerance. The possibility of expressing a color difference as a number has a most important practical application in the industrial control of color uniformity. In any manufacturing process there are usually several factors which determine the color of a finished article. In the ceramic industry the following factors may be considered: (1) glaze preparation, including raw materials; (2) glaze application, determining the final thickness of the fired glaze; and (3) firing temperature. Each one of these factors plays an independent rôle in determining the color of the glazed article. From the standpoint of control, it is necessary to know what changes in color are introduced by the variation in each one of these factors. Any given glaze is studied by applying it in different thicknesses and firing the tile at two extreme temperatures. The color of each tile is then carefully measured, and computations are made to determine the rate of color variations as a function of glaze thickness, *i.e.*, so many judds per thousandth of glaze thickness; or as a function of firing temperatures, *i.e.*, so many judds per degree Fahrenheit. The knowledge of such rates of change in color points directly to factors whose control must be maintained within specific limits so that the final variation in color could be held within predetermined color tolerance. These rates become definite criteria for general expression of color permanency of any material as affected by various measurable physical or chemical agents. Graphs will be shown for a number of representative glazes.

5. Making, Use, and Merchandizing of Faience Tile

By Carl Bergmans: Continental Faience and Tile Co., South Milwaukee, Wis.

6. Indian Pottery Making

By A. E. Baggs: Dept. of Fine Arts, Ohio State Univ., Columbus, Ohio

Movie in colors of Marie and Julian Martinez of San Ildefonso, New Mexico.

7. Electric Kilns for Studio Artists

Discussion led by Arthur E. Baggs: Dept. of Fine Arts, Ohio State Univ., Columbus, Ohio

Art Division Program (continued)

Session at the Oriental Institute, University of Chicago

Tuesday Afternoon, April 18, 1939: 2:00 P.M.

8. Chalcolithic Painted Ware of the Near East

By Robert J. Braidwood: Field Assistant to Syrian Expedition of the Oriental Institute, University of Chicago, Chicago, Ill.

Slides and examples of the earliest painted decoration on pottery will be shown, as well as sherds from various ware made 3000 to 4000 B.C. Special attention will be given to the series from the "Neolithic" village near Persepolis in Persia. This ware was recently excavated and is being installed at the present time.

The talk will be followed by a conducted trip through the Institute.

9. Decorative Tile and Glazed Brick in Antiquity

By N. C. Debevoise, Oriental Institute, Univ. of Chicago, Chicago. Ill.

Glazed tile and brick were used in the Near East before 3000 B.C. The history of the development of this industry, including formulas and extensive examples produced, has been recovered by archeological expeditions in the past decade. Although it is difficult to trace a direct connection of the work with that of modern times, the history is a continuous story in the Near East and probably forms a basis for modern work. A part of the glazed brick Ishtar gateway from the time of Nebuchadnezzar is on exhibit at the Oriental Institute.

Art Division Program (continued)

Hotel Stevens: Private Dining Room 430A

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:00 M.

10. Porcelain, Its Name and History

By W. A. Weldon: 621 Edgewood St., Baltimore, Md.

11. Chinese Ceramics and the Reconstruction of the History of the Provinces of the South China Coast

By Malcolm F. Farley: Archeologist; sixteen years a professor in Fukien Christian University at Foochow, China; at present working at the Field Museum, Chicago, Ill.

The part played by Chinese ceramics in making known the little known history of the South China coastal provinces from early times (about 1000 B.C.) down to the present, particularly the history of China's important ceramic trade with the Near East from A.D. 850 to 1350 will be described.

12. Art of the Modern Japanese Potter (with moving pictures)

By Henry J. Greene: Petersham, Mass.

The pictures will show every step in making pots. The writer worked two different years in Japan, first, with K. Kikko, making Raku ware (used in the tea ceremony) all made by hand. The glaze is fired in 20 minutes in an open furnace, quite different from any other pottery in the world; the writer has found only one American who ever heard of it. The second year, the work was done with S. Hamada and K. Kawai. Bernard Leach of England says Kawai is the best technician in the world. The pictures were taken at the potteries of Hamada and Kawai. Hamada puts on a one-man London show every year, and the prices he gets would make our potters faint.

Art Division Program (continued)

Art Institute of Chicago: Club Room

Wednesday Afternoon, April 19, 1939: 2:00 P.M.

13. Early Chinese Terra Cotta Tile of the Han Dynasty (206 B.C. to 220 A.D.)

By C. F. Kelley: Assistant Director and Curator of Oriental Art, Art Institute of Chicago, Chicago, Ill.

Gray terra cotta tile were in general use in this period. They were low-fired, mostly unglazed, and decorated on the surface with stamped patterns. These were built as hollow, open-ended blocks, 4 or 5 inches thick, about 20 inches wide, and sometimes over 4 feet long. They were evenly fired without cracking. Of this type, the Art Institute of Chicago owns more than 100 which are decorated with more than 200 different stamps. The collections also contain glazed terra cotta of the same period. The talk will be illustrated fully with details of these tile.

After the lecture, Mr. Kelley will conduct the group through the Art Institute to study the ceramic collections in the Museum.

In the school lobby there will be an exhibition of ceramics as designed and produced in the school of the Art Institute.

The library of the Art Institute invites visitors to examine their fine ceramic books. Specimens will be on display.

ENAMEL DIVISION PROGRAM

Chairman: G. H. Spencer-Strong, Porcelain Enamel & Mfg. Co., Baltimore, Md.
Secretary: D. G. Bennett, Mellon Institute, Pittsburgh, Pa.
Program Committee: W. H. Pfeiffer, *Chairman*, Frigidaire Div. of General Motors, Eng. Lab., Plant 2, Dayton, Ohio; L. E. Nordholt, Tennessee Enamel Mfg. Co., Nashville, Tenn.; J. D. Tetrick, Baltimore Enamel & Novelty Co., Baltimore, Md.

Hotel Stevens: South Ball Room

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–11:55 A.M.

9:00–9:30 A.M.

1. Sources of Error in the Determination of Reflectance of Porcelain Enamels

By M. J. Bahnsen and L. S. O'Bannon: Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio

Data are presented showing the amount of error occurring in normal preparation of enamel samples. The various sources of error are discussed and their extent is shown. Suggestions for minimizing these errors are given.

9:30–10:00 A.M.

2. Progress Report on Effect of Particle Size and Index of Refraction on Reflectance

By Burnham W. King, Jr.: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

The effect of the particle size on reflectance was studied by mixing opacifying particles of definite sizes in oil of known index of refraction. The mixtures were applied on a black glass plate in thicknesses from 5 to 15 mils. Several opacifying materials were used to determine the effect of the refractive index of the opacifier.

10:00–10:30 A.M.

3. Hairlining of Sheet-Steel Enamels

By B. J. Sweo and W. M. Paquin: Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio

A laboratory test has been devised which lends itself to the study of hairlining. According to this test, the principal factor contributing to hairlining is metal movement, which is brought about by strain resulting from differential heating during the enameling operation. Photographs indicating a probable mechanism of hairline formation are presented.

10:30–11:00 A.M.

4. Hairlining of Vitreous Enamels, Its Cause and Cure

By J. E. Rosenberg and A. Langerman: O. Hommel Co., Pittsburgh, Pa.

As with many other shop problems, hairlining has not been reproducible under controlled conditions in the laboratory. Experiments show that hairlining is due to a cracking of the bisque before the fusion of the enamel. To produce bisque cracking experimentally in the laboratory, a ground-coated cross-bend strip, 2 by 12 in., was covered on one side with a coating of the enamel being tested. The enamel was dried, and, before firing, it was flexed to a predetermined degree in a Danielson-Lindemann cross-bend machine. The strip was fired, and the degree of hairlining was studied. The effect of various factors, such as grinding fineness, application, clay, and other mill additions, in overcoming hairlining difficulties were determined by this method. Certain materials which overcome hairlining do not prevent bisque cracking, but cause the cracked bisque to heal rather than break away during the firing process. The paper is illustrated with photographs showing the experimental results.

11:00–11:30 A.M.

5. Some Aspects of the Scumming Problem

By G. H. Spencer-Strong and Lawrence McMahon: Porcelain Enamel & Mfg. Co., Baltimore, Md.

The two general types of scumming and their causes are discussed. The sulfate type of scumming is caused by sulfates either in the enamel materials or in the atmosphere to which the ware is exposed. Nonsulfate types of scums are usually caused by a combination of factors which include underfiring, excess water vapor in the furnace atmosphere, fineness of grinding, and mill additions, especially clays and opacifiers.

11:35–11:55 A.M.

6. High-Speed Photography of Glass during Fracture

By Harold E. Edgerton and Frederick E. Barstow: Massachusetts Institute of Technology, Cambridge, Mass.

A joint session with the Glass Division in the North Ball Room (for abstract see Glass Division Program, No. 7, p. 123).

Enamel Division Program (continued)

Hotel Stevens: South Ball Room

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–5:00 P.M.

2:00–2:30 P.M.

7. Study of Some Effects of Sodium Nitrite in Cover Enamels

By L. A. Lange: Chicago Vitreous Enamel Product Co., Cicero, Ill.

An investigation was conducted on the amount of sodium nitrite necessary to control tearing in a given enamel. The effect on rate of drying, scumming tendency, softening point, variations in specific gravity, and behavior of reclaimed enamel was studied. A comparison was also made between adding sodium nitrite as a mill addition and as a solution after milling just before use.

2:30–3:00 P.M.

8. Wet-Process Leadless Cast-Iron Enamels

By B. Niklewski, Jr., and A. I. Andrews: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

Variations in the compositions of wet-process, leadless cast-iron enamels were studied in the development of better enamels. The work was initiated in the laboratory and later was transferred to plant production where the enamels were developed to successful operation. The nonsintered ground-coat and the colored cover enamels applied directly on the iron were particularly satisfactory.

3:00–3:30 P.M.

9. Progress in Developing a Photoelectric Method for Measuring Color Difference

By Richard S. Hunter: National Bureau of Standards, Washington, D. C.

To develop a photoelectric method for measuring the magnitude of color difference, suitable equipment for photoelectric tristimulus colorimetry must be available, and convenient methods must be developed for reducing the data given by this equipment to quantities indicative of magnitude of color difference. The multipurpose reflectometer[1] and its use for approximate photoelectric tristimulus colorimetry[2] have been described. Judd has developed an empirical equation[3] to give uniform color tolerances from colorimetric specifications in his uniform-chromaticity-scale coördinate system.[4] Using Judd's equation and coördinate system as guides, an empirical equation giving magnitude of color difference from tristimulus data taken with the multipurpose reflectometer has been developed.

$$\Delta E = 7.3\left(\frac{G}{G+0.025}\right)\sqrt{G^{1/2}[\Delta\alpha^2+\Delta\beta^2]10^4+\frac{\Delta G^2\cdot 10^4}{300G}}$$

$$\text{Where } \alpha = \frac{2A-2G}{2A+5G+3B}.$$

$$\beta = \frac{G-B}{2A+5G+3B}.$$

A, G, and B are apparent reflectances measured with the amber, green, and blue tristimulus filters, respectively, and ΔE is the magnitude of color difference between two measured samples. This equation was developed for use with the multipurpose reflectometer on the ten standard colors for kitchen and bathroom accessories.[5] It was used to measure color differences between each of the standard plaques and the porcelain-enamel plaques submitted as possible duplicates of the respective standards. The constants of the equations were chosen so that it gave results similar to Judd's in that the maximum color difference which would be tolerated in an average commercial color match measured approximately $\Delta E = 1.0$. Experience with this photoelectric method, however, indicates significant failure to give results which correlate perfectly with visual estimates of color difference. Further attention will be given to the improvement of the equation and the photoelectric equipment.

[1] R. S. Hunter, (*a*) *Bull. Amer. Ceram. Soc.*, **16** [3] 90 (1937); (*b*) *Jour. Optical Soc. Amer.*, **27**, 225 (1937).

[2] R. S. Hunter, *ibid.*, **28**, 51 and 179 (1938).

[3] D. B. Judd, *ibid.*, **28**, 52 (1938).

[4] D. B. Judd, *ibid.*, **25**, 24 (1935).

[5] National Bureau of Standards, Colors for Kitchen Accessories, Commercial Standard CS62–38 (1937) and Colors for Bathroom Accessories, Commercial Standard CS63–38 (1937).

3:30–4:00 P.M.

10. Effect of Various Factors upon Abrasive Resistance of Porcelain Enamels

By Clark Hutchison: Ingram-Richardson Mfg. Co. of Indiana, Inc., Frankfort, Ind.

The amount and kind of opacifiers in use were found to affect abrasive resistance. The clay and water contents, set, and firing conditions also affected the abrasive resistance of some enamels, but fineness of grind and weight of application had no effect. The use of methylene blue as a dye in acid-resisting enamels had no effect on abrasion, nor did method of application of acid-resisting enamels. Four types of enamels were used in this study, *viz.*, an opaque sheet steel, a superopaque sheet steel, an opaque acid-resisting, and a white leadless cast iron. Abrasion tests were made according to the method outlined in the Tentative Standard Test for Resistance of Porcelain Enamels to Surface Abrasion (Porcelain Enamel Institute).

4:00–4:30 P.M.

11. Theory of Enamel Adherence

By J. E. Rosenberg: O. Hommel Co., Pittsburgh, Pa.

A review of prevalent theories of enamel adherence does not explain the function of cobalt compounds in ground coats. The proposed theory is based on the chemical properties of cobalt and its compounds. Although cobalt is more noble than iron and may be replaced from the enamel melt, other metals, such as copper and nickel, which are more readily replaced, do not produce adherence. Cobalt is replaced electrochemically and also acts as an oxidizing agent. This double function of cobalt to plate out and oxidize is proposed as an explanation of its effect in ground coats.

4:30–5:00 P.M.

12. Effect of Humidity on Strength of Enamel Fibers

By D. G. Moore and W. N. Harrison: National Bureau of Standards, Washington, D. C.

Both modulus of rupture and Young's modulus were obtained by transverse loading of annealed fibers of enamel frits, 0.65 to 0.85 mm. in diameter. For the strength tests, both sustained loads and uniformly increasing loads were used. Under the latter loading condition, an increase of 63% in relative humidity resulted in decreases as high as 18% in modulus of rupture. With sustained loading, an increase of 34% in relative humidity caused decreases as high as 35% in modulus of rupture. Young's modulus was not affected by humidity. When tested under uniformly increasing loads, the sheet-iron cover-coat frits were significantly but not greatly stronger than the sheet-iron ground-coat and the cast-iron cover-coat frits.

Enamel Division Program (continued)

Hotel Stevens: South Ball Room

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:00 M.

9:00–9:30 A.M.

13. Application of the Hydrometer Method of Fineness Analysis to Porcelain Enamel Slips

By John C. Reimers: Pfaudler Company, Elyria, Ohio

The application of the hydrometer mechanical analysis for fineness determinations and particle-size distribution has been investigated. Data from the investigation are presented and discussed. The optimum method and procedure, apparatus, etc., are given. The application of the method to enamel raw materials is mentioned briefly, and the general results and conclusions are presented and discussed.

9:30–10:00 A.M.

14. Some Sheet-Iron Enamel Defects Traceable to Base Metal or Metal-Forming Operation

By E. E. Howe: Chicago Vitreous Enamel Product Co., Cicero, Ill.

Cross sections through defects encountered in different plants throughout the country were studied for possible cause of trouble. Those defects which were traceable to some faulty condition in the iron are reported. Hairlines, depressed lines, and blisters in the enamel may originate from some unusual condition in metal before enameling.

10:00–10:30 A.M.

15. An Interesting New Grinding Process

By H. G. Wolfram: Porcelain Enamel & Mfg. Co., Baltimore, Md.

A new type of air-reduction mill is described by means of which materials of widely varying hardness may be reduced to a grain size of approximately 10 microns or less. The new process eliminates iron contamination in grinding and imparts new and improved properties to materials so processed.

10:30–11:00 A.M.

16. Effect of Evacuation on Ground-Coat Enamels

By R. L. Stone and J. J. Amero: Dept. of Ceramic Engineering, Univ. of North Carolina, Raleigh, N. C.

A study was made of the effect on the properties of a ground-coat enamel when subjected to a vacuum of 28 in. of mercury. The results of the investigation show that significant improvement is made upon the aging and adherence properties when the enamel slip is placed under vacuum, especially preceding application.

11:00–11:30 A.M.

17. Laboratory and Shop Performance of Nonreboiling Enameling Sheets

By J. C. Eckel: Carnegie Illinois Steel Co., Pittsburgh, Pa.

A study has been made to determine the flexibility of reboiling and nonreboiling enameling sheets under variations existing in enamel shop practice.

11:30 A.M.–12:00 M.

18. Research Activities of the Porcelain Enamel Institute

By C. S. Pearce: Porcelain Enamel Institute, Chicago, Ill.

The Porcelain Enamel Institute operates in three fields where limited research is necessary. The Sales Promotion Section must study sales problems; the Market Research Section attempts to locate, through research methods, new markets for porcelain enameled products; and the Technical Research Section organizes methods of applying the principles of enamel behavior to the practical problems of application. It is not the intention of these sections to engage in extensive research of a fundamental nature but rather to apply fundamental principles which others have developed to the operating and merchandizing questions which arise in the industry.

Enamel Division Program (continued)

Hotel Stevens: South Ball Room

Wednesday Afternoon, April 19, 1939: 2:00 P.M.–5:00 P.M.

2:00–3:30 P.M.

19. Symposium on Fine Grinding of Cover-Coat Enamels

Led by G. H. Spencer-Strong: Porcelain Enamel & Mfg. Co., Baltimore, Md.

3:30–4:30 P.M.

20. Committee Reports

(a) Standards Committee

By C. R. Amberg, *Chairman:* New York State College of Ceramics, Alfred, N. Y.

The Enamel Division Committee on Standards recommends the adoption of the P.E.I. tests for reflectance and for acid resistance and also a modification of the present fineness test to the extent of expressing results as percentage of frit weight.

(b) Data Committee

By J. E. Rosenberg, *Chairman:* The O. Hommel Co., Pittsburgh, Pa.

The Data Committee of the Enamel Division will report on its activities in preparing for publication a bibliography on porcelain enameling. This bibliography will cover the literature on enameling for the last ten years.

(c) Editorial Committee

By W. N. Harrison, *Chairman:* National Bureau of Standards, Washington, D. C.

(d) Nominating Committee

By G. H. McIntyre, *Chairman:* Ferro Enamel Corp., Cleveland, Ohio.

21. Installation of Officers

22. Gas Opacification of Enamels

By Inaz Kreidl: London, England

Additional title to be scheduled at the discretion of the Division Chairman.

GLASS DIVISION PROGRAM

Chairman: L. C. Roche, Maryland Glass Corp., Baltimore, Md.
Secretary: S. R. Scholes, N. Y. State College of Ceramics, Alfred, N. Y.
Program Committee: N. W. Taylor, *Chairman:* Pennsylvania State College, State College, Pa.; W. R. Lester, Maryland Glass Corp., Baltimore, Md.

Hotel Stevens: North Ball Room

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–11:55 A.M.

9:00–9:30 A.M.

1. Frederick Carder: Dean of American Glass Makers

By Alexander Silverman: Dept. of Chemistry, Univ. of Pittsburgh, Pittsburgh, Pa.

A biographical article and a tribute is presented, illustrated with slides of some of Mr. Carder's masterpieces.

9:30–9:50 A.M.

2. X-Ray Study of Boric Oxide-Silica Glass

By J. Biscoe, C. S. Robinson, Jr., and B. E. Warren: Massachusetts Institute of Technology, Cambridge, Mass.

X-ray diffraction patterns have been made of four samples of boric oxide-silica glass with the composition 15, 30, 45, and 60% by weight SiO_2 and a sample of Pyrex-brand chemical-resistant glass. The samples, in each case, were rods about 1 mm. in diameter. The patterns were made in an evacuated cylindrical camera, using MoK_α radiation monochromated by reflection from a rock-salt crystal. Radial distribution curves, obtained by the usual method of Fourier analysis, can be satisfactorily interpreted by a picture of boric oxide-silica glass, in which each silicon is tetrahedrally surrounded by 4 oxygens at about 1.62 A and each boron is surrounded by 3 oxygens at about 1.39 A. In the resulting random network, each oxygen would be bonded between two cations. The distribution curve of Pyrex-brand chemical-resistant glass is similar to that of vitreous silica, indicating a close similarity in structure. An explanation of the low thermal expansion of vitreous silica in terms of the random network picture of glass is suggested.

9:55–10:15 A.M.

3. High-Temperature Viscosities of Soda-Silica Glasses

By Howard R. Lillie: Corning Glass Works, Corning, N. Y.

A careful study of viscosities of glasses, composed of silica and between 22 and 40% soda, shows that viscosity-composition isotherms are smooth curves. The sharp minima observed by E. Preston at about 34% Na_2O (and possibly at about 26% Na_2O) are found to be entirely absent. Neither time nor shearing stress has any effect upon observed viscosities in the region investigated as long as temperature constancy has been established. A study of deviations of individual points from the smooth isotherms shows that all of these are within the expected limits of experimental error.

10:20–10:40 A.M.

4. Physical Properties and Constitution of Glass

By G. W. Morey: Geophysical Laboratory, Washington, D. C.

10:45–11:05 A.M.

5. Elastic and Viscous Properties of Potash-Silica Glasses in the Annealing Range

By N. W. Taylor and R. F. Doran: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

Several potash-silica glasses were studied by the method described by Taylor and Dear (*Jour. Amer. Ceram. Soc.*, **20** [9] 296–304(1937)). The temperature coefficients of viscosity for the potash-silica glasses were found to be lower than for comparable soda-silica glasses, *i.e.*, the potash-silica series were "sweeter." At a given temperature, the potash glasses were more viscous. The elastic effects were divisible into two stages, instantaneous and delayed. The delayed process was more complex than in the sodium oxide-silica series. A quantitative treatment will be presented.

11:10–11:30 A.M.

6. Dielectric Losses of Glasses at High Temperatures

By Hans Thurnauer: American Lava Corp., Chattanooga, Tenn.; and A. E. Badger: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

A study is presented of dielectric measurements of glasses in the soda–lime–silica system, as well as of other glass compositions, in the frequency range from 100 to 5000 kilocycles.

11:35–11:55 A.M.

7. High-Speed Photography of Glass during Fracture

By H. E. Edgerton and F. E. Barstow: Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Using an electric spark lasting less than one millionth second as a light source, cracks in glass have been successfully photographed during their propagation. A steel ball driven against the glass with a spring initiated fracture and simultaneously actuated an adjustable electrical time-delay circuit, which in turn set off the spark at the required instant. By the use of two sparks, the velocity of propagation of cracks in glass was found to be constant and almost exactly 5040 ft. per sec., the same velocity found by Schardin and Struth. In general, the tips of the cracks form a nearly perfect circle at any particular instant, though some individual photographs show non-symmetry.

Glass Division Program (continued)

Hotel Stevens: North Ball Room

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–4:50 P.M.

2:00–2:20 P.M.

8. Resistance of Glass to Indentation

By Chauncey G. Peters and Frederick Knoop: National Bureau of Standards, Washington, D. C.

The results of an investigation on the cutting of lines in glass with a ground diamond tool and on the resistance of glass to indentations made with diamond tools ground in the form of axe blades and of elongated four-sided pyramids were reported in 1936 (at the Columbus Annual Meeting). The elongated pyramidal tool has been further developed since then. A machine has been constructed for applying loads from 25 grams to 4 kg. The effect of changing the angles between the tool faces and of varying the applied load has been investigated. Measurements have been made on a variety of materials, such as glasses, crystals, metals, porcelains, and thin-plated and treated surface layers. With glass, clear, unshattered indentations, 200 to 300 μ long and 20 to 30 μ wide, were obtained with applied loads of 0.5 to 2.0 kilograms. These dimensions were measured with an accuracy of about 2 μ. The indentation number is defined as $H = W/A$, where W = load (kg.) and A = base or projected area (sq. mm.) of the indentation while the load is being applied. On this scale, most glasses fall in the range 190 to 500. The numbers for some other materials are tin 9, rolled copper 120, annealed steel 270, fused quartz 475, hardened steel 780, crystalline quartz 790, topaz 1250, silicon carbide 2100, boron carbide 2260, and diamond 8200. From measurements of the width of the indentation after the indenter is removed, the recovered area is obtained. The ratio of the recovered to the unrecovered area, R, affords an estimate to be made of the elastic deformation of the material.

2:25–2:45 P.M.

9. Effect of Alumina on Devitrification of Soda-Lime-Silica Glasses

By W. B. Silverman: General Research Lab., Owens-Illinois Glass Co., Toledo, Ohio

The effect of the substitution of Al_2O_3 for the oxides of sodium, calcium, and silicon on the liquidus temperatures and phase relations has been determined for glasses lying within the following composition range: Na_2O 11 to 19%, CaO 6 to 18%, SiO_2 59 to 79%, and Al_2O_3 0 to 8%. Results on 137 individual determinations show that substitution of Al_2O_3 for CaO permits wollastonite to be the primary phase in glasses of relatively low CaO content. As the Al_2O_3 content increases, the $Na_2O{\cdot}3CaO{\cdot}6SiO_2$–$CaO{\cdot}SiO_2$ boundary shifts to lower CaO contents, and the decomposition of $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ to $CaO{\cdot}SiO_2$ takes place at lower temperatures. In compositions with tridymite as a primary phase, substitution of Al_2O_3 for SiO_2 is effective in lowering the liquidus temperature. For the composition range investigated, the SiO_2–$CaO{\cdot}SiO_2$ and $Na_2O{\cdot}3CaO{\cdot}6SiO_2$–$SiO_2$ boundary remains at essentially the same SiO_2 content for all glasses containing not more than 4% Al_2O_3.

2:50–3:10 P.M.

10. Short Methods for Routine Glass Analysis

By P. A. Webster and A. K. Lyle: Engineering Dept., Hartford-Empire Co., Hartford, Conn.

In recent years, analytical methods have been developed which shorten the time required for the determination of many of the constituents found in glass. These short methods have been worked into a procedure for the routine analysis of container and sheet glasses. By careful planning, BaO, SO_3, R_2O_3, CaO, MgO, B_2O_3, Na_2O, and K_2O percentages may be determined on several samples in a single day. Most of the work has been done on Bureau of Standards Glass No. 128, but results from several other glasses are included. Particular care has been taken to discover interfering substances and to eliminate errors from this source.

3:15–3:35 P.M.

11. Notes on Chemical Analysis of Glass

By M. B. Vilensky: Owens-Corning Fiberglas Corp., Newark, Ohio

The old, tedious method of dehydration of silica is replaced with a new, short method. The dehydrating agent used is $HClO_4$ in place of HCl. The evaporation is performed in 1 to 2 hours by employing a specially designed platinum radiator. The complete chemical analysis of glass is made in a very short time. All ingredients of the glass are determined, one after another, by employing the same sample of the material. The alkali contents are determined on a separate sample. Many samples of different glasses have been analyzed with satisfactory results, which are tabulated.

3:40–4:00 P.M.

12. Silicate–Water Systems

By George W. Morey: Geophysical Laboratory, Washington, D. C.

The study of the effect of water under high pressure in lowering the melting points of silicates is an important field of research in geophysics. Water is dissolved by molten silicates in quantity increasing with pressure, and the dissolved water lowers the freezing point of the silicate. An apparatus has been devised which enables quenching to be made in an atmosphere of steam at known pressures and the determination of the resulting freezing-point lowering and amount of dissolved water. Results obtained in the system water–sodium disilicate will be given.

4:05–4:25 P.M.

13. Some Notes on the Effect of Solubility of Glass on the Behavior of the Glass Electrode

By Donald Hubbard, E. H. Hamilton, and A. N. Finn: National Bureau of Standards, Washington, D. C.

The application of an interferometer method, previously used to determine the relative solubility of optical glasses, to a glass commonly used for making glass electrodes, gave results leading to the following conclusions: (1) solubility increases rapidly as the p_H of most solutions increases above 8.5 or 9; (2) at all values below p_H 7 for the solutions investigated (except 10 N H_2SO_4), this glass exhibits a slight swelling; (3) the rate of swelling is repressed in the acid region beyond p_H 2; and (4) at intermediate p_H values, 3.1 to 4.0, the rate of swelling is repressed by high concentrations of magnesium sulfate. Considering these conclusions in connection with the performance of glass electrodes, these regions of marked solubility change correspond to the regions of pronounced voltage departures exhibited by electrodes made from this glass. That the anomalies of the glass electrode are definitely associated with the solubility of the glass has been further demonstrated both by the use of glasses which do not exhibit swelling in the acid range (hence no detectable change of swelling in the "superacid region") and by measurements made in alkaline solutions, such as aqueous ammonia, in which soluble silicates are not formed. Under these circumstances, the voltage departures are greatly decreased or completely eliminated. For every case investigated,

voltage departures of the glass electrode have been found to be accompanied by changes in the solubility of the glass.

4:30–4:50 P.M.

14. White Beach Sands of Baldwin County, Alabama

By R. F. Havell and T. N. McVay: Univ. of Alabama, University, Ala.

These sands, which have been investigated as sources of glass sands, evidently exist in enormous quantities. Beneficiation by means of washing and tabling to remove clay and heavy minerals is indicated. Sands with less than 0.06% Fe_2O_3 content are readily obtained. Mineral analyses of the heavy concentrates show that these consist primarily of kyanite, rutile, tourmaline, staurolite, ilmenite, and zircon.

Glass Division Program (continued)

Hotel Stevens: North Ball Room

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:15 P.M.

9:00–9:20 A.M.

15. Progress Report on the Powder Method of Testing Glass Durability

By F. V. Tooley and C. W. Parmelee: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

The development of a suitable standard procedure of testing the chemical durability of glass by the powder method involves agreement on the conditions under which the testing is performed. To obtain clearly comparable results, a more explicit specification is needed of such conditions as (1) magnitude of the glass surface exposed to attack and (2) nature of the measurement and expression of the extent of the decomposition. This paper is a preliminary report of the results of researches along these fundamental lines.

9:25–9:45 A.M.

16. Effect of Time and Temperature of Test Conditions on Accelerated Chemical Durability Tests Made on Commercial Glass Bottles

By F. R. Bacon and O. G. Burch: Owens-Illinois Glass Co., Toledo, Ohio

Chemical durability results obtained both by crushed sample and surface measurements on a variety of commercial glass bottle compositions show the difficulties encountered in attempting to correlate accelerated tests with the actual performance of glass bottles toward various solutions under service conditions. The results indicate that it is impossible to interpret high-temperature tests with distilled water in terms of resistance of the glasses to distilled water at ordinary temperatures.

9:50–10:10 A.M.

17. Progress Report of the Committee on Chemical Durability of Glass

By G. E. F. Lundell: National Bureau of Standards, Washington, D. C.

10:15–10:35 A.M.

18. Vanadium as a Colorant for Glasses

By A. E. Badger: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.; A. G. Pincus: American Optical Co., Graduate Scholar; and W. A. Weyl: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

Vanadium oxide has been studied to determine its coloring properties in various glasses and glazes. Under ordinary melting conditions, two steps of oxidation may be obtained which give rise to brownish and greenish tints. The chemistry of this colorant closely resembles that of chromium oxide. Comparisons are drawn and absorption curves will be presented.

10:40–11:00 A.M.

19. Some Preliminary Studies on Soda-Silica Glasses Containing Vanadium Oxide

By Kenneth T. Greene: Dept. of Ceramics, Rutgers Univ., New Brunswick, N. J.

A series of glasses containing a constant Na_2O to SiO_2 ratio and increasing amounts of vanadium oxide was studied with reference to refractive index, color, and ease of melting. Vanadium oxide increased the refractive index of the glasses studied. The change in color, which occurred with increasing percentages of vanadium oxide, is believed to indicate a shift in equilibrium between V_2O_3 and V_2O_5.

11:05–11:25 A.M.

20. Color Changes of Glasses When Exposed to Daylight

By W. A. Weyl: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

The color changes of certain types of glasses have been observed for more than 100 years. The best known cases were connected with the use of manganese as a decolorizer. The mechanism of this reaction will be explained and similar phenomena will be discussed. The processes involved are reversible, and in some cases the original color is restored with emission of light (thermoluminescence). Some applications of solarization will be discussed.

11:30–11:50 A.M.

21. Effect of Firing Schedule on Quality of Glass Color Decorations

By Campbell Robertson and Daniel O. Koch: E. I. du Pont de Nemours and Co., R. and H. Chemicals Dept., Perth Amboy, N. J.

A systematic investigation has been undertaken of the effect of the firing schedule on the quality of vitrifiable glass color decorations applied by the screen process. An experimental gas-fired decorating leer with a 30-ft. tunnel was used. The ware was fired at a wide variety of schedules, recorded automatically from thermocouple junctions in contact with the ware, and the schedules were correlated with observations of the finished quality. A definite and fairly sharp critical temperature was indicated for the best elimination of medium, and time at or near this temperature is much more effective than equivalent times at higher or lower temperatures. An "ideal" firing schedule has been tentatively established to serve as a working basis for the improvement of full-scale leer operation.

11:55 A.M.–12:15 P.M.

22. Absorption of Infra-Red Radiation in Molten Glass

By R. J. Havens: Dept. of Physics, Univ. of Wisconsin, Madison, Wis.

A method has been developed for measuring the infra-red absorption spectrum of molten glass. Considerable difficulty was encountered in devising a method of sending the radiation through the molten glass. The best method developed so far is to send the radiation from a Nernst glower through a film of glass suspended between two platinum wires. Preliminary tests on the absorption by the glass at temperatures of 700°, 950°, and 1100°C indicate an increase of the absorption with temperature at wave-lengths greater than 3.8 μ and a marked increase of the absorption near 2.8 μ.

Glass Division Luncheon

Hotel Stevens: Lecture Room, Exhibition Hall

Wednesday Afternoon, April 19, 1939: 12:20 P.M.–1:20 P.M.

LUNCHEON ADDRESS: 1:25–2:25 P.M.

23. Plastics of Today

BY F. W. WARNER: Plastics Dept., General Electric Co., Pittsfield, Mass.

This paper reviews the synthetic organic plastics. It describes the types of plastics, their present importance, the processes by which they are fabricated, their properties, and their uses.

Glass Division Program (continued)

Hotel Stevens: North Ball Room

Wednesday Afternoon, April 19, 1939: 2:30 P.M.–4:40 P.M.

2:30–3:00 P.M.

24. Importance of Surface Tension Data to the Glass Man

BY A. E. BADGER AND C. W. PARMELEE: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

A general discussion is presented on the property of surface tension with particular reference to the practical application in commercial glass manufacture.

3:05–3:25 P.M.

25. Surface-Tension Measurements of Glass by a Modified Dipping Cylinder Method

BY C. L. BABCOCK: General Research Lab., Owens-Illinois Glass Co., Toledo, Ohio

Surface-tension measurements have been made on a series of calcite and dolomite lime glasses, using a modified dipping cylinder method. The measurements cover the temperature range of 1100° to 1400°C, and the viscosity range from $\log \eta = 2$ to $\log \eta = 3.3$. Measurements on ordinary liquids of known surface tensions have been made for check purposes. The results obtained on glasses are in good agreement with published data obtained by the maximum bubble-pressure method. The temperature coefficient of surface tension is approximately −0.02 dyne per cm. per °C. Analysis of the data indicates that the surface tension of a glass at a particular temperature may be represented as a linear function of composition.

3:30–3:50 P.M.

26. Mechanical Methods of Mixing Glass in Continuous Tank Furnaces to Avoid Loss from Striae and Scum

BY R. L. SHUTE: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

A résumé of difficulties arising from this source, a description of equipment, methods of combating these defects, and results obtained from use of these methods are presented.

3:55–4:15 P.M.

27. Report of Progress in Research on Metallurgy of Cast-Iron Glass Molds at the University of Illinois

BY W. H. BRUCKNER, L. R. KOVAC, AND A. B. WILDER: Dept. of Mining and Metallurgy, Univ. of Illinois, Urbana, Ill.

The Department of Mining and Metallurgical Engineering reports the results of a survey of cast-iron glass molds which failed in service. The indicated trends for several irons tested to destruction in an accelerated cracking test are reviewed. New methods of studying growth in cast iron are commented upon, and coöperative interest by the glass industry is urged to broaden the scope of the future research program.

4:20–4:40 P.M.

28. A Window Glass Plant for China

BY SUN KUAN HAN: Univ. of Pittsburgh; EARL FRAZIER, Frazier-Simplex, Inc., Washington, Pa.; AND ALEXANDER SILVERMAN: Univ. of Pittsburgh, Pittsburgh, Pa.

The design and operation of a Fourcault plant for China, with special reference to natural resources and economic factors from the standpoint of Chinese operation is described. Labor and costs are included.

MATERIALS AND EQUIPMENT DIVISION PROGRAM

Chairman: R. B. Carothers, H. C. Spinks Clay Co., Newport, Ky.
Secretary: B. T. Bonnot, Bonnot Co., Canton, Ohio
Program Committee: W. H. Emerson, *Chairman;* Homer Laughlin China Co., East Liverpool, Ohio; B. M. Burchfiel, Gladding, McBean, & Co., Los Angeles, Calif.; S. S. Cole, Titanium Pigment Co., Inc., South Amboy, N. J.; F. E. Finch, Hardinge Co., York, Pa.

Hotel Stevens: Private Dining Room No. 1

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–12:00 M.

1. Residual Alaskite Kaolin Deposits of North Carolina

By Charles E. Hunter: Commerce Dept., Tennessee Valley Authority, Norris, Tenn.

The major residual kaolin deposits of N. C. were formed from large alaskite (F. L. Hess, 1936) granite bodies and not small narrow pegmatite dikes as has been thought. The detailed geologic maps of these deposits in the Spruce Pine area clearly show the large tonnage of reserve kaolin. Although these deposits have long been known and have produced considerable kaolin for ceramic and other uses, few data have been published concerning them. This report should familiarize the American ceramist with this area, enabling him to understand its potentialities.

2. Flotation and Agglomerate Separation of Quartz and Feldspar

By R. G. O'Meara: Southern Expt. Station, Bureau of Mines, Tuscaloosa, Ala.; J. E. Norman: Eastern Expt. Station, Bureau of Mines, College Park, Md.; and W. B. Hammond: Golding-Keene Co., Keene, N. H.

Highly selective methods for separating both soda and potash feldspars from quartz by froth flotation and table agglomeration are described. These separations are far ahead of any previously reported separation, and both high-grade feldspar and quartz concentrates are possible. Cationic reagents as collectors are necessary. Cleaning of the mineral particles by the removal of kaolinization products, iron, and aluminum compounds by mechanical and chemical methods is described. As pulp modifiers, a variety of fluorine-bearing acids and salts are shown to be outstanding in the depression of quartz and activation of feldspar, especially in an acidic pulp. The laboratory results have been checked on a pilot plant scale, and results from a commercial plant have been delayed by damage of the 1938 New England hurricane which caused a recess of construction for the winter months.

3. Physical Properties of Raw Kaolinite as a Function of Its Particle Size

By C. W. Parmelee, C. G. Harman, and Felix Fraulini: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

The properties of a kaolinite which have been studied as a function of particle size are (1) base-exchange capacity, (2) p_H, (3) plasticity, (4) flow properties of suspensions, (5) permeability, (6) drying shrinkage, and (7) dry strength.

4. Effect of Adsorbed Ions on Properties of Monodispersed Clay–Water Systems

By S. Speil: Ceramic Div., Dept. of Metallurgy, Massachusetts Inst. of Technology, Cambridge, Mass.

A sample of Florida kaolin was divided into three practically monodisperse systems averaging 0.6, 0.3, and 0.15 micron, respectively. The size distribution was determined by two independent methods, and the uniformity of the fractions was checked by X-rays and thermal analysis. The fractions were electrodialyzed and then brought to various degrees of saturation with sodium hydroxide. Plasticity, viscosity, drying shrinkage, dried strength, and p_H determinations were made on each fraction. In all cases, definite trends in the physical properties coincided with the amount of adsorbed ion, indicating definitely that the adsorbed ions have an important influence on the physical properties of the clay.

Materials and Equipment Division Program (continued)

Hotel Stevens: Private Dining Room No. 1

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–5:00 P.M.

5. Petrographic and Ceramic Properties of the Coal Measures Shales of Illinois

By R. E. Grim: State Geological Survey Div., Univ. of Illinois, Urbana, Ill.

Coal Measures shales, which are widespread in Illinois, are used extensively as a ceramic raw material. Ceramic determinations (made by the Dept. of Ceramic Engineering, University of Illinois) are given for a large number of shales to illustrate the wide range in their properties. The mineral composition, base-exchange capacity, and textural characteristics are presented for the same shales. The relation of the mineral composition, base-exchange capacity, and textural characteristics to the ceramic properties of the shales is analyzed.

6. Expansion, Contraction, and Strength Changes of Some Clays during Firing

By R. K. Hursh and M. K. Blanchard: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

Linear changes during heating were determined with and without compression loading for two shales and two fire clays. Hot strength tests in flexure were made in the temperature range of 600° to 1400°F.

7. Correlation of Physical Properties of Clays

By C. G. Harman and C. W. Parmelee: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

The fundamental causes of the differences in the working properties of clays may be traced to the difference in the physical form, including crystallographic character and chemical constitution. These variables may be grouped as follows: (*a*) amounts and kinds of minerals present, (*b*) particle-size distribution of each, and (*c*) nature and amounts of soluble salts. These, in turn, govern the factors in (*a*) amount and intensity of solvation, (*b*) net charge on particles, and (*c*) p_H changes when soluble salts are added. This second group of variables control the following properties directly, *viz.*, (1) flow properties of suspensions, (2) plasticity, (3) stability of suspensions, (4) drying shrinkage, (5) permeability, and (6) dry strength.

8. Fractionation of Nonplastic Powders by Sedimentation in Water

By Stanley E. Lull and Arthur S. Watts: Dept. of Ceramic Engineering, Ohio State Univ., Columbus, Ohio

The operation and proving of an apparatus is described for water classification of pulverized nonplastic materials, covering the size range 2 to 48 microns.

Materials and Equipment Division Program (continued)

Hotel Stevens: Private Dining Room No. 1

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:00 M.

9. Newly Discovered Clays in the Dakota Formation of Kansas

By Norman Plummer: Kansas Geological Survey, Univ. of Kansas, Lawrence, Kans.

An intensive investigation of the clays of the Dakota formation in north-central Kansas is being conducted by the State Geological Survey of Kansas. A considerable variety of types of clays occurring in commercial quantities has been tested in the laboratory. These include nearly white- to light buff-firing ball clays and plastic and siliceous fire clays. The Dakota clays may be used in art pottery, stoneware, terra cotta, light-colored face brick, and refractories. The clays in general are characterized by high P.C.E. values, ranging from cones 23 to 29, and by a long firing range.

10. Kyanite in Eastern Alabama

By Edgar Bowles: Staff Geologist, Geological Survey of Alabama, University, Ala.

A brief summary is presented of the occurrence of kyanite in the pre-Cambrian schists of the eastern Alabama Piedmont province. These ores have not been exploited, but their importance as a potential reserve is shown.

11. Viscosity Studies of Dickite Suspensions

By A. W. Helz: Edward Orton, Jr., Ceramic Foundation, Columbus, Ohio

Viscosity studies are reported for suspensions of dickite. A horizontal capillary-tube instrument is used to determine the relation between rate of shear and shearing stress. The effects of oxalic, citric, tannic acids, and $Na_4P_2O_7$ on flow properties of dickite in water suspensions are shown. The specific hydrodynamic volumes of dickite in the water suspensions and also in glycerine are calculated by the equation, $\eta = \eta_0 (1 + 2.5C + 14.1C^2)$. The resulting values are an indication of the degree of deflocculation. Citric acid has a negligible effect on the specific hydrodynamic volume, and oxalic acid and sodium pyrophosphate decrease it nearly to unity. Oxalic and tannic acids give the suspension the property of dilatancy. A brief review of this property with other flow properties of suspensions is included.

12. Report of Committee on Geological Surveys

By H. Ries: Dept. of Geology, Cornell Univ., Ithaca, N. Y.

The Committee will report the progress of work on definitions of clay terms.

Materials and Equipment Division Program (continued)

Hotel Stevens: Private Dining Room No. 1

Wednesday Afternoon, April 19, 1939: 2:00 P.M.–4:00 P.M.

13. Dry Mixing in the Electrical Porcelain Industry

By R. A. Snyder and J. D. Harnish: Westinghouse Electric & Mfg. Co., Derry, Pa.

The plant experience acquired during three years of preparing dry-process porcelain bodies by dry-mixing methods is described. The advantages and disadvantages of this process are discussed.

14. Getting the Best Production from a Ball or Pebble Mill

By O. F. Redd: Patterson Foundry & Machine Co., East Liverpool, Ohio

Mill size, size and shape and amount of grinding media, mill speed, and the amount and consistency of the charge are given in their relation to grinding efficiency.

15. Direct Application of Gas Firing to Ceramic Drying

By Robert Twells and Roy Hummel: Electric Auto-Lite Co., Spark Plug Div., Fostoria, Ohio

Heat for ceramic drying is usually from two sources, *viz.*, steam coils or cooling fired ware. Waste heat from exhaust steam is not available in plants which purchase power, and the use of live steam solely for drying is costly. Waste heat from cooling ware is not always available, and sometimes would cost more to apply than it might save. The products of combustion from burning gas are being used directly for many types of drying with high efficiency and low cost. Two applications of this method to ceramic drying are described.

REFRACTORIES DIVISION PROGRAM

Chairman: N. W. Taylor, Pennsylvania State College, State College, Pa.
Secretary: J. B. Austin, Research Lab., U. S. Steel Corp., Kearny, N. J.
Program Committee: Gilbert Soler, *Chairman:* Steel & Tube Div., Timken Roller Bearing Co., Canton, Ohio; R. S. Bradley, A. P. Green Fire Brick Co., Mexico, Mo.; W. C. Rueckel, Battelle Memorial Institute, Columbus, Ohio

Hotel Stevens: North Assembly Room

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–12:00 M.

General Use of Refractories

(NOTE: Fifteen Minutes Is Allowed for the Presentation of Each Paper; the Remaining Scheduled Time Permits General Discussion.)

9:00–9:15 A.M.

1. Some Properties of Semisilica Brick

By G. Bickley Remmey: Richard C. Remmey Son Co., Philadelphia, Pa.

The most important differences between semisilica and super-duty, first-quality clay and silica brick are shown by comparative tests. A new 24-hour deformation test is described which measures the rate of deformation of brick at various temperatures. First-quality clay brick are shown to have fairly rapid flow at temperatures as low as 2150°F, and super-duty brick at 2350°F; semisilica brick show a zero rate of deformation up to 2650°F. First-quality clay brick vitrify and spall at temperatures as low as 2300°F; under similar conditions, semisilica brick do not vitrify at much higher temperatures. Limitations in the use of semisilica brick are also discussed.

9:30–9:45 A.M.

2. Mottled Silica Brick

By Stuart M. Phelps and Earl C. Petrie: Senior Industrial Fellow and Industrial Fellow, respectively, Refractories Fellowship, Mellon Institute, Pittsburgh, Pa.

Mottled or discolored silica brick have long been a subject of controversy in the industry. During firing for no apparent reason, a brownish discoloration may develop on some of the brick in the kiln. This color only partially covers the brick and usually occurs as blotches more or less circular in shape. A satisfactory explanation for its recurrence in the routine manufacture of silica brick has not been found, and this, together with the hesitancy on the part of some consumers to make use of the discolored product, frequently makes the problem a perplexing one. The literature contains a number of articles dealing with the subject in a more or less general way, and because the results of a study to show the comparative properties of the two products are not available, the present investigation is being made. Brick from various producing districts of the colored and regular product have been carefully compared in their physical and chemical properties, along with petrographic examination. A summary of the literature, comments on the probable cause of discoloration, and a complete bibliography are given.

10:00–10:15 A.M.

3. Conversion of Quartz to Cristobalite and Tridymite

By C. Y. Lin and Nelson W. Taylor: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

About 200 catalytic agents have been studied to determine their effectiveness in reducing the density of silica and producing a well-sintered structure when the material is fired at various temperatures. The results are presented and discussed.

10:30–10:45 A.M.

4. Observations on Slagging of Glass Furnace Checkers

By W. L. Fabianic: Owens-Illinois Glass Co., Alton, Ill.

Two brands of super-duty clay fire brick that had shown a consistent difference in quality when run in several laboratory slag tests were selected for this experiment. Several thousand brick of each brand were put into the opposite regenerator chambers of a large commercial bottle glass furnace, melting a soda-lime glass. One brand failed badly and was definitely inferior to the other. Investigation showed that the superiority of one brand over the other was due directly to the increased percentage of visible mullite.

11:00–11:15 A.M.

5. Blast-Furnace Refractories, Present Application and Possible Future Development

By W. R. McLain: Carnegie-Illinois Steel Corp., South Works, 3426 East 89th St., Chicago, Ill.

Changes in blast-furnace design and operation during the past three decades have been the major factors in increasing blast-furnace campaigns from 500,000 to 2,000,000 tons. Studies of used lining failures indicate that some order of increase in lining life and associated decrease in maintenance cost might follow the use of special refractories in the critical parts of blast-furnace linings. Increased size and operating temperatures of blast-furnace stoves have imposed more severe conditions on refractories, which emphasizes the importance of proper refractory selection.

11:30–11:45 A.M.

6. Mechanical Stokerization of Refractory Firing Kilns

By H. M. Christman: Ceramic Engineer, Massillon Refractories Co., Massillon, Ohio

A description of mechanical stokers used, the problems encountered in their application to rectangular and round kilns, and changes made in original equipment are described. An analysis of the coal best suited for stoker firing, a summation of fuel savings, and the advantages and disadvantages of stoker firing, based on using stokers in regular production over a period of years, are presented.

Refractories Division Program (continued)

Hotel Stevens: North Assembly Room

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–5:00 P.M.

2:00–2:15 P.M.

7. Drying Clays by Induced Ultra-High Frequency Electrical Energy

By T. C. Vaughan, H. E. Rivercomb, W. A. Murray, and J. W. Whittemore: Virginia Polytechnic Inst., Blacksburg, Va.

An apparatus was designed whereby samples of plastic clay could be dried by induced ultra high-frequency electrical energy. Clays were dried by this method, and comparisons were made with drying under controlled relative humidity and heated air. Possible practical applications of this method of drying for ceramic plants are noted.

2:30–2:45 P.M.

8. Recent Developments in Refractory Batch Mixing

By D. A. Moulton: Lancaster Iron Works, Inc., Lancaster, Pa.

The scientific dry mixing of refractories has a decided effect on the physical properties of high-temperature cements, saggers for the pottery kiln, and dry-press fire brick. In the case of refractory cements, it is a means of requiring a minimum of bond for the large percentage of inert material. Dry mixing gives a better and stronger sagger, and it is a step forward in producing dry-press refractories of more uniform physical properties.

Symposium on Refractory Cements and Ramming Mixes

3:00–3:15 P.M.

9. Hardening of Clay-Sodium Silicate Mixtures

By W. R. Morgan: Dept. of Ceramics, Rutgers Univ., New Brunswick, N. J.

The hardening of clay-sodium silicate mixtures as a result of reaction with soluble salts and by means of base-exchange reactions has been studied. It is more or less obvious that the hardening of these mixtures is related to refractory cement hardening.

3:30–3:45 P.M.

10. Investigation of Certain Properties of Refractory Concrete

By R. T. Giles: Atlas Lumnite Cement Co., 135 E. 42nd St., New York, N. Y.

The relation of cold strengths to strengths after heating is shown, and data are presented from which wall strengths may be calculated. The development of fired strength begins at 1500°F, at which temperature some of the hydraulic or cold strength remains. Selection of the aggregate is important to the development of fired strength. The effect on the fired strength of the addition of percentages of low vitrification clay to high vitrification aggregates is shown. Data are given on shrinkage.

4:00–4:15 P.M.

11. A New Kind of Cement for Silica Brick

By J. W. Craig and N. P. Pitt: Canadian Refractories, Ltd., Montreal, Quebec

Performance records in steel and copper furnaces and glass tanks are tabulated. The life of silica brick has been considerably increased by laying with a new type of cement whose chief characteristics are plasticity and water retention. The process of plasticizing has also been applied to refractory cements with chrome, magnesia, fireclay, diaspore, and sillimanite bases.

4:30–4:45 P.M.

12. Fundamental Concepts on Thermal Conductivity of Refractory Materials

By A. Eucken: Translated and presented by W. C. Rueckel, Battelle Memorial Institute, Columbus, Ohio; discussion by J. B. Austin, U. S. Steel Corp., Kearny, N. J.

Eucken presents a theory of thermal conductivity based on the crystal, glass, and pore contents of refractory materials. A mathematical treatment using a modified form of the Maxwell equation for one, two, and three phase systems is presented, and thermal conductivity values are calculated from values for crystal and glass phases found in silica, clay, sillimanite, and basic brick. The data show why essentially crystalline refractories, such as silicon carbide, etc., have a falling conductivity curve with increased temperature while the thermal conductivity of clay brick increases with an increase in temperature.

Refractories Division Program (continued)

Hotel Stevens: North Assembly Room

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:15 P.M.

Laboratory Tests and Fundamental Data

9:00–9:15 A.M.

13. Refractories Research and Development Laboratory of the Ceramic Department, North Carolina State College

By R. L. Stone: Dept. of Ceramic Engineering, Univ. of North Carolina, Raleigh, N. C.

Drawings of laboratory equipment for forming, firing, and testing refractories are given. A forming pressure of 12,500 lb. per sq. in. is attainable in a small hydraulic press. A gas-fired high-temperature kiln of $1^1/_2$-cu. ft. capacity may be fired to cone 30. The P.C.E. furnace will reach cone 33 with manufactured city gas and air, and cone 36 with city gas and oxygen. Most of the equipment was made in the college machine shop. Other equipment, including a humidity control drier, a slag furnace, and a thermal-expansion furnace, is described.

9:30–9:45 A.M.

14. Small Electric Arc Furnace for Melting and Pouring Glasses and Corrosive Slags

By James A. Taylor: Mineral Industries Expt. Station, Pennsylvania State College, State College, Pa.

An electric arc furnace was built to replace the gas furnace (described in *Jour. Amer. Ceram. Soc.*, **19** [2] 39–44 (1936)). This furnace is quick and melts difficult substances with ease. The advantages of the radiation type of melting and the ease with which test pieces may be made in a pure state are discussed and described.

10:00–10:15 A.M.

15. Laboratory Slagging-Test Furnace with a Rotating Burner

By R. K. Hursh: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

A furnace is described in which uniform heat treatment and slag application are given to panels of test brick by a rotating gas burner through which the slag is fed in powdered form. Temperature gradients in the test panels and some test data are given.

10:30–10:45 A.M.

16. Critical Examination of Load Test for Refractories

By F. H. Norton: Dept. of Metallurgy, Massachusetts Inst. of Technology, Cambridge, Mass.

The load test for refractories has received a great deal of study both in this country and abroad, but the tests in general do not give any information which the designer may directly use in furnace construction. The standard tests are usually suited for checking the uniformity of a product. A type of test proposed, which will more nearly simulate actual conditions of service, exposes the brick for a considerable length of time to a constant load and a constant temperature and determines the rate of deformation much in the same way that creep tests are carried out on steel. (Published *Jour. Amer. Ceram. Soc.*, **22** [2] 54–63 (1939).)

11:00–11:15 A.M.

17. Deformation of Insulating Fire Brick under Load

By C. L. Norton, Jr., and V. L. Duplin, Jr.: Refractories Div., Babcock & Wilcox Co., New York, N. Y.

An electrically heated furnace and the method for applying loads to full-sized insulating fire brick, which have been heated throughout to thermal equilibrium, is described. Sixteen commercial brands of insulating fire brick of various use limits were tested under several loads over a range of temperatures, and no correlation was found to exist between weight and resistance to hot load or between cold crushing strength and hot load-bearing capacity.

11:30–11:45 A.M.

18. Determination of Quartz (Free Silica) in Refractory Clays

By L. J. Trostel and D. J. Wynne: General Refractories Co., Baltimore, Md.

A rapid procedure is described for determining the quartz in refractory clays by fusion in potassium bisulfate and subsequently dissolving the precipitated silica with a hot caustic solution. Data on the quartz content of several clays are included.

12:00 M.–12:15 P.M.

19. Adapting Miniature Cameras to Petrographic Photomicrography

By P. S. Dear: Dept. of Ceramics, Virginia Polytechnic Inst., Blacksburg, Va.

A composite apparatus by means of which miniature cameras may be adapted to petrographic photomicrography is described. Detail drawings of the various parts are included, and examples of the application of the apparatus to problems in ceramic technology are given.

Refractories Division Luncheon and Business Meeting

Hotel Stevens: Boulevard Room

Wednesday Afternoon, April 19, 1939: 12:15 P.M.–2:15 P.M.

Refractories Division Program (continued)

Hotel Stevens: North Assembly Room

Wednesday Afternoon, April 19, 1939: 2:30 P.M.–5:00 P.M.

Fundamental Data

2:30–2:45 P.M.

20. Length and Thermal Changes of Flint and Aluminous Clays during Heating

By R. A. Heindl and L. E. Mong: National Bureau of Standards, Washington, D. C.

Changes in length and endothermic and exothermic heat effects between room temperature and 1000°C were measured on flint clays from Kentucky, Missouri, Ohio, Pennsylvania, and Washington, a plastic clay from Pennsylvania, a hard kaolin and a bauxitic clay from Georgia, and a Zettlitz kaolin and a diaspore from Missouri. Changes in length of unpulverized and of finely pulverized materials were measured in air and in an atmosphere of the products of gas combustion. The two ranges of temperature (approximately 500° to 600°F and 925° to 980°C), during which rapid contraction took place, were the same as those in which the endothermic and exothermic reactions occurred. The ranges in temperature at which rapid contraction took place were slightly lower for the pulverized than for the unpulverized clays, except for the Missouri clay, which showed no difference.

3:00–3:15 P.M.

21. Investigation of the Thermal Dissociation of Diaspore Clay

By P. G. Herold and C. M. Dodd: School of Mines and Metallurgy, Univ. of Missouri, Rolla, Mo.

Diaspore clay, under conditions of equilibrium, forms corundum and α-alumina at 400°C. The α-alumina gradually changes to corundum at higher temperatures, part of which combines with free silica to form mullite at about 1150°. Between 400° and 750°, there is a gradual increase in the size of the corundum unit cell as determined by X-ray crystal analysis, which, upon continued heating at higher temperatures, gradually reduces to the true dimensions of corundum.

3:30–3:45 P.M.

22. Cone Fusion Study of Mixtures of Zirconium Silicate-Silica-Alumina

By R. F. Rea: Denver Fire Clay Co., Denver, Colo.

Alumina and alumina-silica mixtures have a strong fluxing effect on zirconium silicate. A eutectic between $ZrSiO_3$ and Al_2O_3 occurs approximately at 20% Al_2O_3 and melts at cone 31. The ternary eutectic has the approximate composition of 70% SiO_2, 15% $ZrSiO_3$, and 15% Al_2O_3 and a P.C.E. of cone 27. (Published *Jour. Amer. Ceram. Soc.*, **22** [3] 95–96 (1939).)

4:00–4:15 P.M.

23. A Study of the Recrystallization of Magnesia

By H. G. Schurecht: N. Y. State Ceramic Expt. Station, Alfred, N. Y.; and Van Derck Fréchette: Dept. of Ceramic Engineering, Univ. of Illinois, Urbana, Ill.

X-ray studies show that lightly calcined magnesite is cryptocrystalline, with an atomic structure identical with that of periclase and fused magnesia.

4:30–5:00 P.M.

24(a). Use of Aluminum Metal in the Ceramic Industry: I, Some Properties of Ceramic Bodies Produced with Mixtures of Aluminum, Fire Clay, and Grog

By H. G. Schurecht and H. I. Sephton: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

Aluminum powder was used to produce new ceramic bodies and to improve other bodies. Heat generated by aluminothermic reactions between aluminum and clay improved the strength and porosity of refractories. The use of aluminum to facilitate the firing of ceramic bodies was demonstrated merely by heating them to 950°C and allowing the heat of reaction to carry the temperature beyond this point.

(b). II, Petrographic Study of Aluminum Clay Mixtures after Firing

By J. F. McMahon, C. M. Lampman, and M. E. Dykeman: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

The mineral composition of fired aluminum clay mixtures was identified. Corundum and mullite as well as metals were present. The structure of the mixtures in some cases was highly crystalline, which explains certain of their properties.

(c). III, Some Properties of Ceramic Bodies Produced with Mixtures of Aluminum, Magnesite, and Chromite

By B. Spiro and L. H. Washburn: N. Y. State College of Ceramics, Alfred, N. Y.

The addition of aluminum powder to magnesite-chromite mixtures greatly improved their strength as a result of aluminothermic reactions with the aluminum. These reactions started at lower temperatures with the chromite than with the magnesite. Some of these bodies are promising for use as refractories.

A.I.M.M.E. OPEN-HEARTH COMMITTEE

The Open-Hearth Committee of the A.I.M.M.E. is holding its annual meeting at Cleveland, April 26, 27, and 28, 1939. The Wednesday afternoon session will be devoted to the discussion of open-hearth refractory problems.

L. F. Reinartz, chairman of the Open-Hearth Committee, has extended an invitation to members of the Refractories Division of the American Ceramic Society to attend this meeting and to enter into the discussion.

The Committee hopes to develop closer cooperation between producers of refractories and users through discussions held at these meetings.

STRUCTURAL CLAY PRODUCTS DIVISION PROGRAM

Chairman: T. W. Garve, 314 King Ave., Columbus, Ohio
Secretary: H. Z. Schofield, Engineering Experiment Station, Ohio State Univ., Columbus, Ohio
Program Committee: E. W. Knapp, *Chairman;* 31 W. University St., Alfred, N. Y.

Hotel Stevens: Private Dining Room No. 2

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–12:00 M.

1. Internal Structure of Paving Brick and Its Relation to Properties of the Ware

By G. A. Bole: Engineering Expt. Station, Ohio State Univ., Columbus, Ohio

Microphotographs of thin sections were taken with transmitted light and in reflected light. Some of these photographs were taken using a colorant in the body to bring out the glass phase, and the history of a crack is recorded by means of microphotography.

2. Apparatus for the Determination of Water Permeability of Brick

By R. T. Stull and P. V. Johnson: National Bureau of Standards, Washington, D. C.

A method devised for sealing the specimen in the permeability box has the following advantages over the former method: (1) rapidity of operation; the sealing is accomplished by a rectangular rubber tube inflated to 70 lb.; (2) elimination of application of a sealing liquid or glaze to the vertical surfaces of the brick; the undamaged brick may thus be used for other tests; (3) permeability through the entire uninterrupted flat faces of the brick; and (4) the apparatus may be used for air-permeability determinations, especially above the pressure limited by a mercury seal. An improved type of pressure regulator of high sensitivity was developed.

3. Standard Wicks for Testing Efflorescence of Masonry Materials

By C. M. Lampman: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

To standardize a wick test for testing efflorescence on masonry materials, a specimen with a definite pore structure and a low soluble salt content was developed. Comparable results in different parts of the country may be obtained with this test.

4. Resistance of New York State Brick to Freezing

By H. G. Schurecht and J. F. McMahon: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

Shale brick and soft-mud brick were tested to ascertain their resistance to freezing when compared with their absorption and saturation coefficient (C to B ratios). The results indicate that the saturation coefficient by itself is not a trustworthy method to predict freezing resistance.

5. Precast Tile Joist Floor System

By Henry Giese: Dept. of Agricultural Engineering, Iowa State College, Ames, Iowa; and C. T. Bridgman: Regional Director, Structural Clay Products Institute, Ames, Iowa

A floor system is described which was developed in the Agricultural Engineering Section of the Agricultural Experiment Station in connection with a research fellowship sponsored by the Iowa Association of Clay Products Manufacturers. This system consists essentially of precast beams, which serve as joists, filler blocks laid from beam to beam, and a covering of concrete. By using only one specially shaped block, floors may be constructed which vary widely in length of span and in load capacity from light residential construction to that suitable for warehouses. An extensive series of tests as a basis for design tables is given, and illustrations will show the procedure in fabricating and typical construction jobs.

6. Betterment of Clay Flue Liners

By Paul E. Cox and H. Ford Muecke: Iowa State College, Ames, Iowa

The behavior of four factory-produced sets of liners under thermal-shock treatment was studied. Using a 5- by 8-in. die with an auger machine, a large number of small liners were made from many mixtures of clays from the four commercial plants. These liners were tested in a specially constructed furnace-and-chimney device for thermal-shock behavior. From these tests, a combination of fire sand and the usual flue-liner clays should give greatly improved service of liners in chimneys. A sewer-pipe plant made 50 such liners, using fire sand and their own clays. Tested in a specially built fireplace and chimney of the usual home-heating sort, these liners proved to be at least ten times better than any commercial liner. Incidental problems are discussed.

Structural Clay Products Division Program (continued)

Hotel Stevens: Private Dining Room No. 2

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–5:00 P.M.

7. Reinforced Brick Masonry

By Edward A. Tapper: Davidson Brick Co., Los Angeles, Calif.

A letter, with accompanying drawings, describes conditions of buildings following a series of earthquakes.

8. Influence of Internal Lubrication in a Plastic Clay Body on Drying and Fired Characteristics

By H. R. Straight: Straight Engineering Co., Adel, Iowa

A treatment applied to clay in the plasticizing processes, which reduces internal friction in a die or form-molded ceramic shape, is described. The methods of application and determination of the correct proportion of treatment are given briefly.

9. Automatic Electric Cutter

By E. A. Hawk: 333 Hamerley Court, S. E., Canton Ohio

10. Solution of an Unusual Brick Manufacturing Problem

By F. E. Lobaugh: Alfred, N. Y.; and H. C. Harrison: Dept. of Chemistry, N. Y. State College of Ceramics, Alfred, N. Y.

Knobs, of about 1 in. diameter and white spindling growths 6 in. long, were developed in the manufacture of building brick. With the use of the spectroscope, small traces of zinc were discovered to be the cause of these growths. The zinc came from metal used to hold the tires on the mullers. The phenomena were duplicated accurately by laboratory experiment.

11. The Circle System for the Manufacture of Clay Products

By J. R. Clark: Washington Brick Co., Muirkirk, Md.

This paper explains (1) the layout of the plant, (2) the type of structures and materials used, (3) the system of operation, (4) methods of drying, preheating, and firing, (5) the conservation and use of waste heat, and (6) the low labor and fuel requirements.

12. Use and Advantages of Insulating Fire Brick in the Circle System

By J. D. McCullough: Babcock & Wilcox Co., 19 Rector St., New York, N. Y.; and G. M. Frederick: Babcock & Wilcox Co., Packard Bldg., Philadelphia, Pa.

The insulating refractories used in the movable hoods of the Circle System are described.

Structural Clay Products Division Program (continued)

Hotel Stevens: Private Dining Room No. 2

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:00 M.

13. Factors Regulating the Correct Amount of Ware to Be Set in Downdraft Kilns for Greatest Economy

By J. G. Seanor: Alliance Brick Co., Darlington, Pa.

For rapid and economical firing in downdraft kilns, furnace gases must be circulated rapidly through the ware. Too much ware set in a kiln will defeat the benefits to be derived from forced-draft furnaces and strong draft on the exhaust flue, owing to frictional resistance between furnace gases and ware. Because water, carbon, and sulfur are removed from the ware in the form of gas, the volume of these gases will choke the kiln and will defeat the forced-draft furnaces and high stack draft if too much ware is set in the kiln. Experiments indicate that the height of the setting is more important than the space between the ware. With this information, hollow tile is now set so that it is fired in 40 to 48 hr. with no over- and under-firing, and with pleasing fuel savings. The firing time on buff and gray face brick has been reduced $3\frac{1}{2}$ or 4 days, with the elimination of defective ware and the advantage of good fuel savings. All of the experiments have been made with 36-ft. round downdraft kilns.

14. Use and Economy of a Rotary Drier in Manufacture of Brick and Tile

By J. W. Whittemore: Dept. of Ceramics, Virginia Polytechnic Institute, Blacksburg, Va.

The use of a rotary drier at the Roanoke-Webster Brick Co., Roanoke, Va., is discussed. The capacity of this plant has been greatly increased by drying the tailings from the screens, thereby increasing the capacity of the grinding equipment.

15. Furnaces and Kiln Bottoms

By L. R. Whitaker: Richland Shale Products Co., Richtex, S. C.

A dead-bottom furnace was redesigned without the sloping firing arch. The horizontal firing arch provides a coking plate to close the firing arch with fuel, and the furnace provides a means to control the oxidizing and reducing conditions. The floor openings were changed by steps from open-bottom to four small openings in the center. The effect of these changes on the quality of ware and coal consumption is discussed.

16. Factors Influencing the Performance of a Brick and Tile Drier

By L. R. Whitaker: Richland Shale Products Co., Richtex, S. C.

This list is made up as a study of those things that contribute to the good performance or failure of a drier. A completed list of these factors would be instructive in diagnosing drier trouble and improving drier efficiency. The drier is often blamed for the trouble caused in some phase of the manufacturing before or after the ware is placed in the drier. These factors are discussed briefly; other factors and other means to improve drier operation are open for discussion.

(1) Clays: (*a*) as mined, (*b*) proper mixing, (*c*) preparation.
(2) Uniform pugging.
(3) Proper de-airing.
(4) Augers: (*a*) auger worn, (*b*) correct auger and distance from die, (*c*) the die and its condition from wear.
(5) Correct lubrication.
(6) Careful hacking.
(7) Drier cars: (*a*) condition, (*b*) careful transfer, (*c*) schedule of entering cars.
(8) Reprecipitation: effect on ware and cars.
(9) Driers: (*a*) low exhaust, (*b*) high exhaust.
(10) Driers: (*a*) too long, (*b*) too short.
(11) Space between ware on cars to drier roof and walls.
(12) Volume: (*a*) low intake, (*b*) high intake.
(13) Pressure: (*a*) low intake, (*b*) high intake.
(14) Temperature: (*a*) low, (*b*) high.
(15) Humidity: (*a*) low, (*b*) high.
(16) Size of flue openings: (*a*) under cars, (*b*) some distance below tracks or just under car axles, (*c*) balancing.
(17) Distance openings extend into tunnels.
(18) Design of tunnel-flue intakes.
(19) Baffles to balance tunnels, vertical or horizontal.
(20) Air entering distributing flue in front or side of drier.
(21) Flues: (*a*) too small, (*b*) wet, (*c*) insulation of waste-heat flues.
(22) Fans: (*a*) type, (*b*) size.
(23) Waste heat: (*a*) volume, (*b*) position and size of opening for withdrawal.

17. Improved Machine Shows Different Forms of Failure of Clay Bodies in Torsion

By R. P. Graham and J. D. Sullivan: Battelle Memorial Inst., Columbus, Ohio

An improved torsion apparatus for studying the workability of clays is described in detail. The study showed that the initial failure of solid clay bars in torsion occurs in lines approximately parallel to the axis of the bars, if the clays are plastic or slake to fine particles on addition of

water, and perpendicular to the axis for nonplastic and nonslaking clays. Ultimate failure in both cases is approximately perpendicular to the axis. Initial failure of the bar also occurs simultaneously with the maximum torque transmitted by the bar. (Published *Bull. Amer. Ceram. Soc.*, **18** [3] 97–100 (1939).)

18. Workability of Clays

By R. P. Graham and J. D. Sullivan: Battelle Memorial Inst., Columbus, Ohio

Stress-strain relationships were established in a torsion machine on six clays with varying water content in the workable stiff-mud range. Torsion tests gave the following measurements: (1) yield point, (2) maximum torque, (3) angle of deformation at maximum torque, and (4) angle of deformation at ultimate failure. Lawrence clay exhibited the highest angle at maximum torque and angle at ultimate failure of the plastic clays studied. Georgia kaolin had a low yield point, maximum torque, and angle at maximum torque. Workability in the stiff-mud range is not necessarily a measure of workability of the same bodies with different moisture contents.

Structural Clay Products Division Program (continued)

Hotel Stevens: Private Dining Room No. 2

Wednesday Afternoon, April 19, 1939: 2:00 P.M.–5:00 P.M.

19. Factors Involved in Improvement of Clays through *p*H Control

By George J. Barker and Emil Truog: College of Engineering, Univ. of Wisconsin, Madison, Wis.

The p_H-controlled process of clay treatment will produce beneficial results if proper information on the clay is available before treatment. The p_H curve usually will supply this information. Three different types of curves are presented and discussed. Soluble salts affect the process. These effects and manner of control are explained. Actual tests which have been made in plant operations during the past year are referred to and the results obtained are described.

20. Experiments with the Waverly Shale to Increase the Tried Strength and Plasticity

By James Child: Hancock Brick & Tile Co., Findlay, Ohio

This particular deposit of Waverly shale produced a body with an undesirably low dry strength. Various chemical additions as well as various mechanical treatments were given this material to increase the dry strength. Mechanical treatment included various degrees of fineness of grinding, as well as processing the pugged clay through smooth rolls and re-pugging. The additions to the shale consisted of acid, soda-ash, sodium silicate, Plasticade, bentonite, plastic surface clay, sodium aluminate, sodium-aluminate gel, as well as some combinations of these materials. The flow characteristics, dry shrinkage and dry strength, fired shrinkage and fired strength, and absorption were taken on all of the test batches.

21. Zinc-Vapor Glazing of Clays: II, Effect of Lime in Clay on Zinc-Vapor Glaze Colors

By C. M. Lampman and H. G. Schurecht: New York State Ceramic Expt. Station, Alfred, N. Y.

It was commonly thought that high lime clays do not take a good green zinc-vapor glaze. Fairly good greens, however, were obtained when the bodies were sufficiently vitrified and had a high iron-oxide content. The color is somewhat more yellow than that obtained from lime-free bodies.

22. Terra Sigillata Engobes

By J. F. McMahon: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

Experiments were conducted to reproduce the ancient Roman "terra sigillata" engobes from New York clays. Better colors were produced in this manner, and the engobes were almost glazelike in density and hardness. They do not mash the detail in sculptured ware, but they tend to cover body scumming and discolorations.

23. Inventory-Taking of Structural Clay Products Research Programs

Discussion by Harry C. Plummer: Chief Engineer, Structural Clay Products Inst., Washington, D. C.; and Frederick Heath, Jr., Colonial Clays, Inc., Worcester, Mass.

Assuming that an inventory would be helpful to research workers in structural clay products, the discussion will endeavor to bring out for tabulation research work recently completed, under way, or planned as follows:

(A) By Manufacturers
  (1) National
    (*a*) S.C.P.I., (*b*) N.P.B.A., (*c*) G.B. & T.I.
  (2) Regional
    (*a*) S.C.P.I. 1-W, (*b*) 1-C, (*c*) C.P.I. Calif., (*d*) Cleveland Clay League, (*e*) B.M.A.N.Y., etc.
  (3) At Plants
    (*a*) Natco, (*b*) Hanley, (*c*) Belden, (*d*) Binghamton, etc.

(B) By Institutions
  (1) National
    (*a*) Bureau of Standards, (*b*) Bureau of Mines, (*c*) A.S.T.M., (*d*) A.S.A., etc.
  (2) Regional
    (*a*) Ceramic Expt. Station, (*b*) Eng. Expt. Station, (*c*) TVA, (*d*) M.I.T., (*e*) Iowa, etc.
  (3) Colleges and Universities
    (*a*) Staff, (*b*) Student Thesis
  (4) Testing Laboratories, private inventors, etc.

WHITE WARES DIVISION PROGRAM

Chairman: F. P. Hall, Onondaga Pottery Co., Syracuse, N. Y.

Secretary: Karl Schwartzwalder, A C Spark Plug Co., Flint, Mich.

Program Committee: Harry Thiemecke, *Chairman;* Homer Laughlin China Co., Newell, W. Va.; Ralston Russell, Jr., Engineering Expt. Station, Ohio State Univ., Columbus, Ohio; W. W. Meyer, National Bureau of Standards, Washington, D. C.

Hotel Stevens: West Ball Room

Tuesday Forenoon, April 18, 1939: 9:00 A.M.–12:00 M.

1. Further Developments in Dry Mixing of Ceramic Bodies

By F. A. Fix: Lancaster Iron Works, Inc., Lancaster, Pa.

Dry mixing of ceramic bodies continues to attract widespread attention. Actual cases of these advantages, such as more uniformity in the finished ware, improvement in physical structure, reduced processing costs, reduction of scrap, and the available flexibility in the preparation of different ceramic-body formulas, are discussed.

2. Some Factors Affecting the Physical Properties of a Dry-Mixed Body

By C. H. Rapp: A C Spark Plug Co., Flint, Mich.

The influence of such factors as mixing time, sequence of compounding the mixture, and the use of sodium silicate or acetic acid in the tempering water upon the physical properties of a typical electrical-porcelain body are discussed. Such properties as state of vitrification, water absorption, apparent specific gravity, shrinkage, and modulus of rupture are considered.

3. Effect of Wetting Agents and Other Additions on Properties of a Dry-Mixed Whiteware Body

By J. F. McMahon and C. M. Lampman: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

The effect of wetting agents, soda ash, and sodium alginate on some properties of dry-mixed whiteware bodies was studied, and a marked improvement was produced in certain cases. Their effectiveness becomes greatest with more than 5% water content.

4. The Electrodeposition of Ceramic Bodies

By Rufus N. Palmer: Mellon Institute, Pittsburgh, Pa.

The process of shaping ceramic articles by electrodeposition in metal molds was investigated (1) to determine how the properties of the deposits varied with the conditions under which the deposits were made, (2) to determine the best operating conditions, (3) to compare the finished articles with ceramic castings, and (4) to see if the products were satisfactory economically.

5. Serviceability of Pottery Plasters: II, Influence of Setting Properties upon Life of Plaster Molds

By J. F. McMahon and H. G. Schurecht: N. Y. State Ceramic Expt. Station, Alfred, N. Y.

Plasters with a long setting range and slow setting properties produce better molds than those with a short setting range and fast setting properties.

6. Some Properties of Clay Casting Slips

By G. A. Loomis: Engineering Expt. Station, Ohio State Univ., Columbus, Ohio

Data are presented on the grain-size, p_H value, consistency, specific gravity, and casting rate of clay casting slips.

White Wares Division Program (continued)

Hotel Stevens: West Ball Room

Tuesday Afternoon, April 18, 1939: 2:00 P.M.–5:00 P.M.

7. Early History of the Electrical Porcelain Industry in the United States

By A. S. Watts: Dept. of Ceramic Engineering, Ohio State Univ., Columbus, Ohio

A compilation of historical data from 1888 to about 1900 is presented. The material is contributed by officers of the early manufacturing companies, and it is supplemented by available published data. The materials used, the methods of manufacture, and the types of product are discussed.

8. Radio Condenser Porcelain from Magnesia, Clay, and Talc Mixtures

By F. K. Tracey and C. H. Vance: New York State College of Ceramics, Alfred, N. Y.

Mixtures of magnesia, clay, and talc were investigated to determine their utility for radio-condenser insulators. Two bodies, which are promising, contain MgO 40, talc 24, and clay 36, and MgO 40 and 60 parts clay, respectively. Precipitated MgO produced good bodies at cone 14; cone 19 was necessary to produce the required vitrification for bodies containing fused MgO.

9. Method of Recording the Plastic Properties of Porcelain Bodies

By L. E. Thiess: General Electric Co., Schenectady, N. Y.

The plastic working properties of a series of high-tension porcelain bodies have been tested on an apparatus called the "Plastograph." The data have been correlated with other physical properties, such as grain size, amount of organic (carbonaceous) matter, and dry strength.

10. Glaze Defects and Tunnel Kiln Firing Practice

By A. J. Blume: Square D Co., Moulded Insulation Div., Peru, Ind.

Certain glaze difficulties are related to kiln firing practice and may be corrected by changes in kiln operation. The causes underlying blistering and pinholing on single-fired porcelain are discussed and suggestions are made as to heating rates and kiln atmosphere. The necessity for a soaking or refining period after the peak temperatures have been reached is discussed.

11. Inconsistencies in the Application of Oxide Factors to the Control of Glaze Properties

By Laurence E. Kane: Dept of Ceramics, Rutgers Univ., New Brunswick, N. J.

Observations of the results of substitution, particularly in the field of porcelain glazes, illustrate variable tendencies of expansion characteristics and other properties. Simple corrective measures which may be used as a control method are brought out.

12. Benefits of Coöperative Research to the Floor- and Wall-Tile Industry

By J. R. Kauffman: Dept. of Ceramics, Rutgers Univ., New Brunswick, N. J.

A résumé of the results and accomplishments of an industrial fellowship established in 1931 is presented. The development of simulative tests, standardization, quality control, and new installation methods as well as improvement in manufacture, composition, and the introduction of special types of tile are reviewed.

White Wares Division Program (continued)

Hotel Stevens: West Ball Room

Wednesday Forenoon, April 19, 1939: 9:00 A.M.–12:00 M.

13. Classification of Dinnerware

By A. S. Watts: Dept. of Ceramic Engineering, Ohio State Univ., Columbus, Ohio

A report of progress is presented in developing this classification to meet the demands both of the producer and the buyer.

14. Summary of United States Potters Association Fellowship Work

By J. H. Koenig: Hall China Co., East Liverpool, Ohio

(1) *Solubility Tests on Colored Glazes:* Commercial colored glaze specimens from a number of plants were subjected to solubility tests employing various agents. Tests on colored glazeware for metallic solution in various food and fruit acids are reviewed.

(2) *Physical Properties of Dinnerware Bodies and Glazes:* The purpose of the investigation was to give to the various manufacturers fundamental data on their commercial bodies, glazes, and ware. In some plants, complete information has not been available, owing to a lack of testing facilities. Tests on the ware include chipping and impact resistance, warpage, thermal quenching, autoclave tests, glaze microtexture, gloss measurements, and glaze hardness. Tests on the dry, fired, and glazed specimens include shrinkages; flexural, tensile, and compressive strength; elasticity; and fatigue. Other tests were thermal expansion of body, glaze, and glazed body specimens, moisture expansions, etc. Specimens received the commercial firing treatments.

15. Final Progress Report on Plastic Primary North Carolina Kaolins, Methods of Their Use, Development of Vitreous Bodies, and Experiments with a Continuous, High-Temperature, Electric Tunnel Kiln

By the Tennessee Valley Authority Ceramic Research Laboratory Staff: Norris, Tenn.

(I) Notes on a Year's Testing of Plastic Type North Carolina Primary Kaolins

By R. E. Gould and A. J. Hedquist

Supplement to Part I: Comparative Study of Acid- and Base-Binding Capacities and Viscosity Relations in A and B Clays

By E. C. Henry: Dept. of Ceramics, Pennsylvania State College, State College, Pa.

(II) Further Development and Testing of a True Porcelain and Vitreous China Dinnerware Body Using North Carolina Kaolin as the Chief Plastic Constituent

By R. E. Gould and A. J. Hedquist

(III) Notes on Casting All-Kaolin Bodies

By A. J. Hedquist, E. Wilson, and R. E. Gould

(IV) Notes on Laboratory Experiments in Production of Flatware

By R. E. Gould and G. W. Fichter

(V) Electric Kilns and Furnaces

By R. E. Gould, M. G. Toole, and M. S. Nelson

(VI) Heat Balance on Pilot Kiln

By M. G. Toole and M. S. Nelson

(VII) Probable Heat Loss and Efficiency of a Theoretical, Commercial Electric Kiln

By M. G. Toole and M. S. Nelson

16. Factors Affecting the Life of Kiln Furniture in the Whiteware Industry

By Grant S. Diamond: Electro Refractories & Alloys Corp., Lackawanna, N. Y.

Kiln furniture, such as saggers and batts, yields variable service owing to variable conditions in ceramic kilns. Mechanical design of the kiln furniture and the tunnel cars quite often determines the economy and efficiency of settings. Temperatures and cycles determine the dimensions and types of refractories required. Recommended sizes of batts and saggers for maximum density of loading are affected by the type of refractory used and by the heat curve of the kilns. Recommendations are made on the optimum conditions and designs for satisfactory service.

White Wares Division Program (continued)
Hotel Stevens: West Ball Room
Wednesday Afternoon, April 19, 1939: 2:00 P.M.–5:00 P.M.

17. Use of Nepheline Syenite in Floor- and Wall-Tile Bodies

By C. J. Koenig: Engineering Expt. Station, Ohio State Univ., Columbus, Ohio

The physical properties of 10 wall-tile bodies and 5 floor-tile bodies are described. The wall-tile bodies are respectively fluxed with nepheline syenite; feldspar; talc and feldspar; talc and syenite; talc, pyrophyllite, and syenite; and talc, pyrophyllite, and feldspar. Floor-tile bodies developing at lower temperatures may be formulated with nepheline syenite. American clays were used in these bodies. The greater refractoriness of American clays as compared to English clays is compensated for by the increased fluxing action of nepheline syenite.

18. General Properties of Garspar

By George J. Bair and Rufus N. Palmer: Mellon Institute, Pittsburgh, Pa.

A study of the characteristic properties of Garspar is described. Garspar is a ceramic raw material consisting of an intimate mixture of quartz and processed flux. Data on its chemical composition, particle size, fusibility, fluxibility, thermal expansion, and moisture expansion are presented. The fluxing characteristics of Garspar are explained by means of the Garspar–clay–feldspar triaxial system.

19. Properties of Garspar in Whiteware Bodies

By George J. Bair and Rufus N. Palmer: Mellon Institute, Pittsburgh, Pa.

The properties of vitreous, semivitreous, and sanitaryware bodies containing Garspar were investigated. Various substitutions were made in typical bodies and their effect on the following properties was determined: workability and castability, dry and fired strength, absorption, shrinkage, vitrification range, elasticity, thermal expansion, moisture expansion, warpage, translucency, and color. The actions of the usual auxiliary fluxes were studied in Garspar bodies.

20. Aplite, a New Ceramic Material

By P. S. Dear and J. W. Whittemore: Dept. of Ceramics, Virginia Polytechnic Inst., Blacksburg, Va.

The chemical and mineralogical content and the physical properties of zoisitic aplite rock, mined in Amherst County, Va., and milled in Nelson County, Va., have been investigated. The possibilities of various ceramic uses of the zoisitic aplite are discussed.

21. Utilization of North Carolina Kaolin in Casting Bodies

By William H. Earhart: Engineering Expt. Station, Ohio State Univ., Columbus, Ohio

The effect of changes in American kaolins and ball clays on the casting properties of bodies of the sanitaryware or electrical-porcelain type is shown. Data show that just as satisfactory casting properties and deflocculation characteristics may be obtained by the use of American clays as with English clays. Tests used to define the casting properties of bodies include (1) general deflocculation curves, (2) adjustment of specific gravities, (3) adjustment of electrolyte content by the so-called "feel test," (4) determination of the viscosity after the "feel-test" adjustment, (5) determination of the rates of cast (grams wet and dry clay cast in 30 minutes), (6) dry and fired transverse strengths, and (7) fired absorptions and bulk specific gravities. The replacement of English clays by American clays generally requires some adjustment in flux content of the body to obtain corresponding vitrifications. Typical body compositions containing American kaolins and ball clays are given, showing the percentages of feldspar and syenite necessary to give zero absorption at cones 10 and 12.

22. Business Session

ROUND TABLE DISCUSSION OF METHODS OF ANALYSIS OF SILICATES AND SILICATE PRODUCTS

Hotel Stevens: South Ball Room

Thursday Forenoon, April 20, 1939: 9:30 A. M.–12:00 M.

Sponsored by the Committee on Analytical Procedures: E. W. Koenig, *Chairman;* G. E. F. Lundell and F. C. Flint; *Division Representatives:* M. Boszin, *Enamel;* G. H. Chambers, *Materials and Equipment;* L. J. Trostel, *Refractories;* and W. R. Lester, *Glass.*

1. Standardization of Analysis of Barium-Boron Glass

DISCUSSION LED BY (*a*) G. E. F. LUNDELL: National Bureau of Standards, Washington, D. C.; AND (*b*) W. R. LESTER: Maryland Glass Co., Baltimore, Md.

2. Analytical Determination of Free Oxides in Refractories

DISCUSSION LED BY LOUIS J. TROSTEL: General Refractories Corp., Baltimore, Md.

3. Mercury Cathode in Analysis of Refractory Materials, Particularly for Chrome Products

BY JOHN D. SULLIVAN: Battelle Memorial Institute, Columbus, Ohio

In analyzing ceramic products, considerable difficulty is often encountered by iron, chromium, and other elements. Elaborate separations and purifications are often used. The mercury cathode is suggested as a rapid and inexpensive method to effect such separations. No elaborate equipment is necessary.

4. Analyses of Feldspar, Rutile, and Zirconium Silicate

DISCUSSION LED BY M. BOSZIN: Ferro Enamel Corp., Cleveland, Ohio

5. Semidirect Determination of Potassium Oxide in Feldspars

BY E. W. KOENIG: Consolidated Feldspar Corp., Erwin, Tenn.

A method for the evaluation of potassium oxide in feldspars without the necessity of first removing the constituents, which usually interfere with this determination, is described. The procedure is based upon a decomposition with $HF–HClO_4$, followed by the separation of potassium as the double salt $((K, Na)_3CO(NO_2)_6xH_2O)$, with a final conversion to $KClO_4$ in the usual manner. Analytical data are given to indicate the relative precision and accuracy of the method compared with procedures in use at the present time. The application of the proposed method to the analyses of other silicates is mentioned briefly.

6. Direct Determination of Sodium Oxide in Feldspar

BY E. W. KOENIG: Consolidated Feldspar Corp., Erwin, Tenn.

A method for the direct determination of sodium oxide in feldspars is described. Data derived from an investigation conducted to determine the optimum conditions for the accurate estimation of this alkali metal by the prescribed procedure are tabulated and the results are discussed. The application of the method to the analysis of other related silicates is mentioned briefly. (Published *Jour. Amer. Ceram. Soc.*, **22** [1] 24–31 (1939).)

7. Use of Bromate in Volumetric Analysis: VII, Potentiometric Titration of Hydroxyquinoline

BY G. F. SMITH AND R. L. MAY: Chemical Laboratories, Univ. of Illinois, Urbana, Ill.

The potentiometric titration of 8-hydroxyquinoline and the metallic inner complexes, *i.e.*, magnesium oxyquinolate, is described, using direct titration with a standard bromate solution of the hydrochloric acid solution of the hydroxyquinoline or its derivatives with particular reference to magnesium oxyquinolate. Potentiometric procedures for direct determination have been developed using the electrode system, platinum nickel. This procedure involves the use of the monometallic, platinum-platinum electrode pair and the electron beam sectrometer as the recording instrument, which has a distinct advantage of speed and equal accuracy over previous electrometric titrations. A series of experimental analyses has been carried out both on the hydroxyquinoline and its magnesium salt. The procedure is well adapted to routine plant control analyses, and a separation of calcium prior to the determination of magnesium is not required. (Published *Jour. Amer. Ceram. Soc.*, **22** [1] 31–33 (1939).)

AUTHOR INDEX TO ANNUAL MEETING PROGRAM CONTRIBUTORS

NOTE: The letters in parentheses indicate the session or Division in which the author is listed; the number following is the number of the paper. *The number at the right is the page number.* (A) Art, (AP) Analytical Procedure, (E) Enamel, (G) Glass, (GS) Glaze Symposium, (ME) Materials and Equipment, (R) Refractories, (SC) Structural Clay Products, (TH) Thermal History, (W) White Wares.

Albery, D. F. (TH9) 115.
Amberg, C. R. (E20a) 122.
Amero, J. J. See Stone, R. L. (E16) 122.
Andrews, A. I. See Niklewski, B. (E8) 121.

Babcock, C. L. (G25) 126.
Bacon, F. R., and Burch, O. G. (G16) 125.
Badger, A. E., and Parmelee, C. W. (G24) 126.
Badger, A. E., Pincus, A. G., and Weyl, W. A. (G18) 125.
Badger, A. E. See Thurnauer, H. (G6) 123.
Baggs, A. E. (A6, A7) 118.
Bahnsen, M. J., and O'Bannon, L. S. (E1) 120.
Bair, G. J., and Palmer, R. N. (W18,19) 138.
Balinkin, I. A. (A4) 118.
Barker, G. J., and Truog, E. (SC19) 135.
Barringer, L. E. 114.
Barstow, F. E. See Edgerton, H. E. (G7) 123.
Bell, W. C. (GS3) 116.
Bergmans, Carl (A5) 118.
Biscoe, J., Robinson, C. S., Jr., and Warren, B. E. (G2) 123.
Blanchard, M. K. See Hursh, R. K. (ME6) 127.
Blume, A. J. (W10) 137.
Bole, G. A. (SC1) 133.
Boszin, M. (AP4) 139.
Bowles, Edgar (ME10) 128.
Braidwood, R. J. (A8) 119.
Bridgman, C. T. See Giese, Henry. (SC5) 133.
Bruckner, W. H., Kovac, L. R., and Wilder, A. B. (G27) 126.
Burch, O. G. See Bacon, F. R. (G16) 125.

Campbell, R. M. (GS2) 116.
Carruthers, J. L. (TH2) 115.
Child, James (SC20) 135.
Christman, H. M. (R6) 129.
Clark, J. R. (SC11) 134.
Commons, C. H., Jr. See Kinzie, C. J. (GS9) 117.
Cowan, R. G. (TH7) 115.
Cox, P. E., and Muecke, H. F. (SC6) 133.
Craig, J. W., and Pitt, N. P. (R11) 130.
Creamer, A. S. See Geller, R. F. (GS5) 116.

Dear, P. S. (R19) 131.
Dear, P. S., and Whittemore, J. W. (W20) 138.
Debevoise, N. C. (A9) 119.
Diamond, Grant (W16) 137.
Dodd, C. M. See Herold, P. G. (R21) 131.
Doran, Robert. See Taylor, N. W. (G5) 123.
Dougherty, W. E. (GS10) 117.
Dressler, Philip (TH1) 115.
Duplin, V. L., Jr. See Norton, C. L., Jr. (R17) 131.
Dykeman, M. E. See McMahon, J. F. (R24b) 132.

Earhart, W. H. (W21) 138.
Eckel, J. C. (E17) 122.
Edgerton, H. E., and Barstow, F. E. (E6) 120; (G7) 123.
Enthof, E. (A2) 118.
Eucken, A. (R12) 130.

Fabianic, W. L. (R4) 129.
Farley, M. F. (A11) 119.
Fichter, G. W. See Gould, R. E. (W15) 137.
Finn, A. N. See Hubbard, D. (G13) 124.
Fix, F. A. (W1) 136.
Fraulini, Felix. See Parmelee, C. W. (ME3) 127.
Frazier, Earl. See Han, S. K. (G28) 126.
Fréchette, Van Derck. See Schurecht, H. G. (R23) 132.
Frederick, G. M. See McCullough, J. D. (SC12) 134.
Fritz, E. H., and Harrison, H. C.† (TH5) 115.

Geller, R. F., and Creamer, A. S. (GS5) 116.
Giese, Henry, and Bridgman, C. T. (SC5) 133.
Giles, R. T. (R10) 130.
Gould, R. E., and Fichter, G. W. (W15) 137.
Gould, R. E., and Hedquist, A. J. (W15) 137.
Gould, R. E., Toole, M. G., and Nelson, M. S. (W15) 137.
Gould, R. E. See Hedquist, A. J. (W15) 137.
Graham, R. P., and Sullivan, J. D. (SC17) 134; (SC18) 135.
Greene, H. J. (A12) 119.
Greene, K. T. (G19) 125.
Grim, R. E. (ME5) 127.

Hall, F. P. (GS4) 116.
Hamilton, E. H. See Hubbard, D. (G13) 124.
Hammond, W. B. See O'Meara, R. G. (ME2) 127.
Han, S. K., Frazier, Earl, and Silverman, Alexander (G28) 126.
Harman, C. G. (GS1) 116.
Harman, C. G., and Parmelee, C. W. (ME7) 127.
Harman, C. G. See Parmelee, C. W. (ME3) 127.
Harnish, J. D. See Snyder, R. A. (ME13) 128.
Harrison, H. C.,* Lawrence, W. G., and Tucker, D. J. (GS6) 117.
Harrison, H. C.† See Fritz, E. H. (TH5) 115.
Harrison, H. C.* See Lobaugh, F. E. (SC10) 134.
Harrison, W. N. (TH4) 115; (E20c) 122.
Harrison, W. N. See Moore, D. G. (E12) 121.
Havell, R. F., and McVay, T. N. (G14) 125.
Havens, R. J. (G22) 125.
Hawk, E. A. (SC9) 133.
Heath, Frederick, Jr. See Plummer, H. C. (SC23) 135.
Hedquist, A. J., Wilson, E., and Gould, R. E. (W15) 137.
Hedquist, A. J. See Gould, R. E. (W15) 137.
Heindl, R. A., and Mong, L. E. (R20) 131.
Helz, A. W. (ME11) 128.
Henry, E. C. (W15) 137.
Herold, P. G., and Dodd, C. M. (R21) 131.
Howe, E. E. (E14) 122.
Hubbard, D., Hamilton, E. H., and Finn, A. N. (G13) 124.
Hummel, Roy. See Twells, Robert (ME15) 128.
Hunter, C. E. (ME1) 127.
Hunter, R. S. (E9) 121.
Hursh, R. K. (R15) 131.
Hursh, R. K., and Blanchard, M. K. (ME6) 127.
Hutchison, Clark (E10) 121.

Johnson, A. L. (GS8) 117.
Johnson, P. V. See Stull, R. T. (SC2) 133.

Kane, L. E. (W11) 137.
Kauffman, J. R. (W12) 137.
Kelley, C. F. (A13) 119.
King, B. W., Jr. (E2) 120.
Kinzie, C. J., and Commons, C. H., Jr. (GS9) 117.
Knecht, A. O. (GS7) 117.
Knoop, Frederick. See Peters, C. G. (G8) 124.
Koch, D. O. See Robertson, C. (G21) 125.
Koenig, C. J. (W17) 138.
Koenig, E. W. (AP5, AP6) 139.
Koenig, J. H. (TH6) 115; (W14) 137.
Kovac, L. R. See Bruckner, W. H. (G27) 126.
Kreidl, I. (E22) 122.

Lampman, C. M. (SC3) 133.
Lampman, C. M., and Schurecht, H. G. (SC21) 135.
Lampman, C. M. See McMahon, J. F. (R24b) 132; (W3) 136.
Lange, L. A. (E7) 120.
Langerman, A. See Rosenberg, J. E. (E4) 120.
Lawrence, W. G. See Harrison, H. C.* (GS6) 117.
Lester, W. R. (AP1b) 139.
Lillie, H. R. (G3) 123.
Lin, C. Y., and Taylor, N. W. (R3) 129.
Lobaugh, F. E., and Harrison, H. C.* (SC10) 134.
Loomis, G. A. (W6) 136.
Lull, S. E., and Watts, A. S. (ME8) 128.
Lundell, G. E. F. (G17) 125; (AP1a) 139.
Lyle, A. K. See Webster, P. A. (G10) 124.

May, R. L. See Smith, G. F. (AP7) 139.
McCullough, J. D., and Frederick, G. M. (SC12) 134.
McIntyre, G. H. (E20d) 122.
McLain, W. R. (R5) 129.
McMahon, J. F. (SC22) 135.
McMahon, J. F., and Lampman, C. M. (W3) 136.
McMahon, J. F., Lampman, C. M., and Dykeman, M. E. (R24b) 132.
McMahon, J. F., and Schurecht, H. G. (W5) 136.
McMahon, J. F. See Schurecht, H. G. (SC4) 133.
McMahon, L. See Spencer-Strong, G. H. (E5) 120.
McVay, T. N. See Havell, R. F. (G14) 125.
Mong, L. E. See Heindl, R. A. (R20) 131.
Moore, D. G., and Harrison, W. N. (E12) 121.
Morey, G. W. (G4) 123; (G12) 124.
Morgan, W. R. (R9) 130.
Moulton, D. A. (R8) 130.
Muecke, H. F. See Cox, P. E. (SC6) 133.
Murray, W. A. See Vaughan, T. C. (R7) 130.

Neff, V. O. (A3) 118.
Nelson, M. S. See Gould, R. E. (W15) 137.
Nelson, M. S. See Toole, M. G. (W15) 137.
Niklewski, B., Jr., and Andrews, A. I. (E8) 121.
Norman, J. E. See O'Meara, R. G. (ME2) 127.
Norton, C. L., Jr., and Duplin, V. L., Jr. (R17) 131.
Norton, F. H. (R16) 131.

O'Bannon, L. S. See Bahnsen, M. J. (E1) 120.
O'Meara, R. G., Norman, J. E., and Hammond, W. B. (ME2) 127.

Palmer, R. N. (W4) 136.
Palmer, R. N. See Bair, G. J. (W18,19) 138.
Paquin, W. M. See Sweo, B. J. (E3) 120.
Parmelee, C. W., Harman, C. G., and Fraulini, Felix (ME3) 127.
Parmelee, C. W. See Badger, A. E. (G24) 126.
Parmelee, C. W. See Harman, C. G. (ME7) 127.
Parmelee, C. W. See Tooley, F. V. (G15) 125.
Pearce, C. S. (E18) 122.
Peters, C. G., and Knoop, Frederick (G8) 124.
Petrie, E. C. See Phelps, S. M. (R2) 129.
Phelps, S. M. and Petrie, E. C. (R2) 129.
Pincus, A. G. See Badger, A. E. (G18) 125.
Pitt, N. P. See Craig, J. W. (R11) 130.
Plummer, H. C., and Heath, Frederick, Jr. (SC23) 135.
Plummer, Norman (ME9) 128.

Rapp, C. H. (W12) 136.
Rea, R. F. (R22) 131.
Redd, O. F. (ME14) 128.
Reimers, J. C. (E13) 122.
Remmey, G. B. (R1) 129.
Rhead, F. H. (A1) 118.
Ries, H. (ME12) 128.
Rivercomb, H. E. See Vaughan, T. C. (R7) 130.
Robertson, C., and Koch, D. O. (G21) 125.
Robinson, C. S., Jr. See Biscoe, J. (G2) 123.
Rosenberg, J. E. (E11) 121; (E20b) 122.
Rosenberg, J. E., and Langerman, A. (E4) 120.
Rueckel, W. C. (R12) 130.
Russell, R., Jr. (TH8) 115.

Schurecht, H. G., and Fréchette, Van Derck (R23) 132.
Schurecht, H. G., and McMahon, J. F. (SC4) 133.
Schurecht, H. G., and Sephton, H. I. (R24a) 132.
Schurecht, H. G. See Lampman, C. M. (SC21) 135.
Schurecht, H. G. See McMahon, J. F. (W5) 136.
Seanor, J. G. (SC13) 134.
Sephton, H. I. See Schurecht, H. G. (R24a) 132.
Shute, R. L. (G26) 126.
Silverman, Alexander (G1) 123.
Silverman, Alexander. See Han, S. K. (G28) 126.
Silverman, W. B. (G9) 124.
Smith, G. F., and May, R. L. (AP7) 139.
Snyder, R. A., and Harnish, J. D. (ME13) 128.

† Westinghouse Electric & Mfg. Co.

* New York State College of Ceramics.

Speil, S. (ME4) 127.
Spencer-Strong, G. H. (E19) 122.
Spencer-Strong, G. H., and McMahon, Lawrence (E5) 120.
Spiro, B., and Washburn, L. H. (R24c) 132.
Stone, R. L. (R13) 130.
Stone, R. L., and Amero, J. J. (E16) 122.
Straight, H. R. (SC8) 133.
Stull, R. T., and Johnson, P. V. (SC2) 133.
Sullivan, J. D. (AP3) 139.
Sullivan, J. D. See Graham, R. P. (SC17) 134; (SC18) 135.
Sweo, B. J., and Paquin, W. M. (E3) 120.

Tapper, E. A. (SC7) 133.
Taylor, J. A. (R14) 130.
Taylor, N. W., and Doran, Robert (G5) 123.
Taylor, N. W. See Lin, C. Y. (R3) 129.
Thiess, L. E. (W9) 137.
Thurnauer, H., and Badger, A. E. (G6) 123.
Toole, M. G., and Nelson, M. S. (W15) 137.
Toole, M. G. See Gould, R. E. (W15) 137.
Tooley, F. V., and Parmelee, C. W. (G15) 125.
Tracey, F. K., and Vance, C. H. (W8) 136.
Trostel, L. J. (AP2) 139.
Trostel, L. J., and Wynne, D. J. (R18) 131.
Truog, E. See Barker, G. J. (SC19) 135.
Tucker, D. J. See Harrison, H. C.* (GS6) 117.
TVA Report (W15) 137.
Twells, Robert, and Hummel, Roy (ME15) 128.

Vance, C. H. See Tracey, F. K. (W8) 136.
Vaughan, T. C., Rivercomb, H. E., Murray, W. A., and Whittemore, J. W. (R7) 130.
Vilensky, M. B. (G11) 124.

Warner, F. W. (G23) 126.
Warren, B. E. See Biscoe, J. (G2) 123.
Washburn, L. H. See Spiro, B. (R24c) 132.
Watts, A. S. (W7) 136; (W13) 137.
Watts, A. S. See Lull, S. E. (ME8) 128.
Webster, P. A., and Lyle, A. K. (G10) 124.
Weldon, W. A. (A10) 119.
Weyl, Woldemar (TH3) 115; (G20) 125.
Weyl, W. A. See Badger, A. E. (G18) 125.
Whitaker, L. R. (SC15, SC16) 134.
Whittemore, J. W. (SC14) 134.
Whittemore, J. W. See Dear, P. S. (W20) 138.
Whittemore, J. W. See Vaughan, T. C. (R7) 130.
Wilder, A. B. See Bruckner, W. H. (G27) 126.
Wilson, E. See Hedquist, A. J. (W15) 137.
Wolfram, H. G. (E15) 122.
Wynne, D J. See Trostel, L. J. (R18) 131.

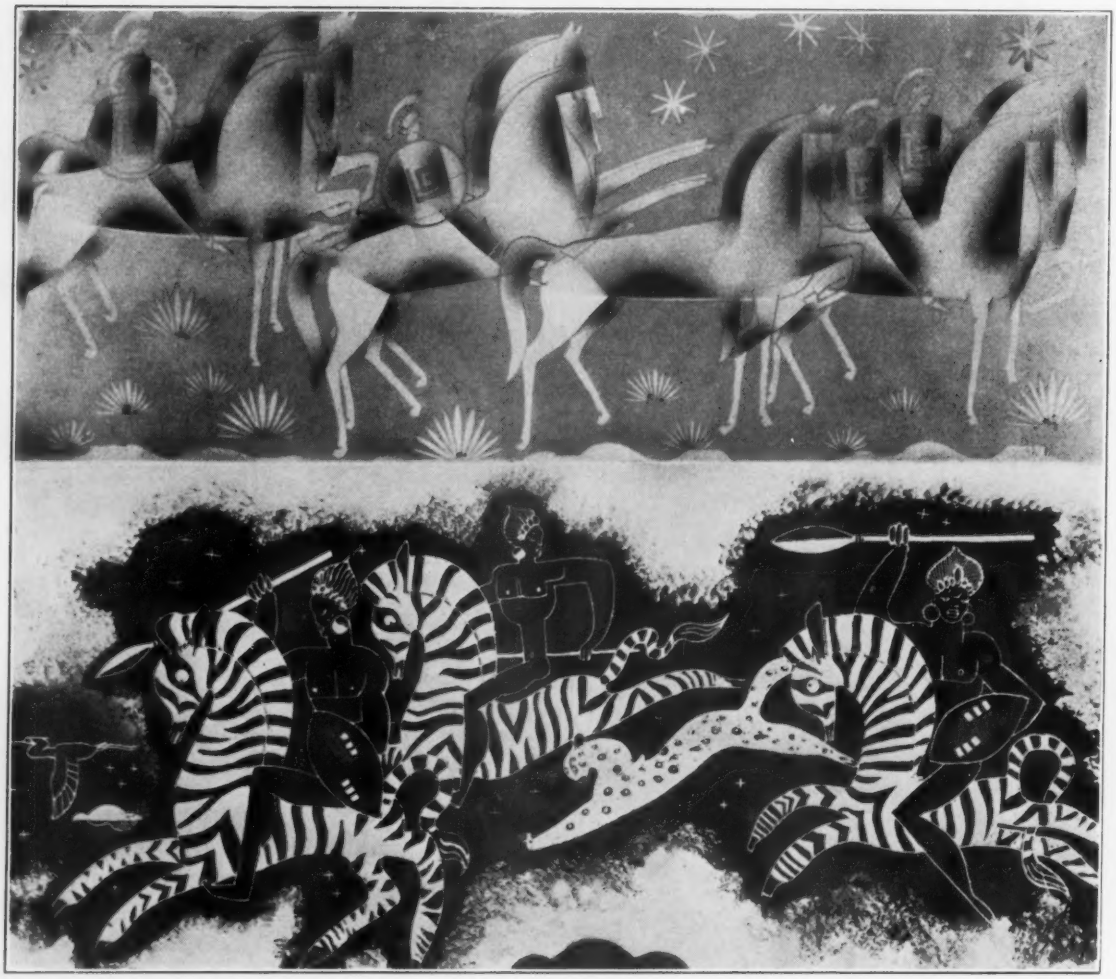
NATIONAL CERAMIC EXHIBITION

For seven years, Anna W. Olmsted, Director of the Syracuse Museum of Fine Arts, has managed an exhibition of ceramic fine arts. Each year this exhibition has grown in quality and quantity. The "rejects" from the 1938 Exhibit would have been placed and some received rewards in the 1932 exhibit.

For three years, a portion of the Exhibit has toured the principal museums of the United States. In 1937, the Exhibit was shown in Europe.

The Seventh National Ceramic Exhibition was divided. One-half has been set up at the Golden Gate World's Fair in San Francisco, and the other half has been sent on a tour of American museums.

The American Ceramic Society is pleased with the opportunity of showing this Exhibit at its Forty-First Annual Meeting.



Armageddon, (top) enamel panel by H. Edward Winter, Cleveland, Ohio; (bottom), "Fantasy", by Russel Barnett, Aitken, New York, N. Y. Mr. Winter and Mr. Aitken divided the first prize of $100 given by the Ferro Enamel Corp., Cleveland, Ohio. For other photographs of prize-winning pieces at this Exhibition, see *Bull. Amer. Ceram. Soc.*, **17** [12] 482–84 (1938).

THE BULLETIN
OF THE AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society and Promotion of Coöperative Research of Technical, Scientific, and Art Questions

Volume 18 **APRIL, 1939** **Number 4**

PAPERS

RING-SECTION EXAMINATION OF GLASS CONTAINERS*

By V. C. Swicker

Abstract

Regular periodic examination of cross sections of glass containers with the polarizing microscope has proved to be a valuable adjunct to recognized strength tests. The method is described, and its usefulness in the prediction of ware serviceability and as a means of glass quality control is explained.

I. Introduction

The technical application of the polarizing microscope to the examination of sections cut from glass containers is a comparatively recent development. Prior to 1930, the technical literature contained practically no references to the cross-section examination of containers for cords and inhomogeneities. Wright[1] presented data in which the physical properties of cords were discussed and methods for diagnosis were described. At about the same time, the late Arthur E. Williams, then chief chemist of the Hartford-Empire Company, started to apply this type of examination to glass manufacturing problems. This was probably the impetus to the technical application of microscopic methods for glass quality control. During the next few years, little was published on this subject until the studies of Ewald[2] in 1929 and Lester[3] in 1932. Since that time, other valuable contributions have been made, including studies of flow lines in bottle forming, shown by the distribution of cords throughout the bottle.

II. Purpose

The ring-section type of examination is used to determine and to evaluate the degree of cordiness of the glass in containers. Because the examination is based on the use of cross sections, it gives a truer picture of actual conditions than can be obtained by any other means available. It also supplements the general polariscopic examination, but it is not intended to supplant it.

III. Equipment

The equipment required consists, in general, of a microscope and a cutting machine for the preparation of the sections. The microscope (a polarizing type) must be equipped with a sensitive tint plate (first order red). The magnification is kept low enough to give a field wider than the wall thickness of the section. The ring is rotated by hand for complete section examination. These conditions are usually attained by using a 48-mm. objective and a 7.5× ocular, giving a total magnification of 15. For routine purposes, the illuminator may be of the substage type.

Figure 1 shows the setup which is used in the laboratory of the Hartford-Empire Company. The table was specially designed for this type of work, the top being resistant to the action of solvents, such as monochlorbenzene, which is the immersion liquid used. Figure 2 shows the details of the microscope assembly.

IV. Samples and Preparation

In making a detailed examination of a container, sections should be cut from the side wall, the base, and the "finish." For routine purposes, however, an unbroken side-wall ring section about $^5/_8$ in. thick is usually sufficient to give a good estimate of the quality of the glass.

Although suitable sections may be cut from some types of bottles with a hot electric wire, other types can not be cut satisfactorily by this means; it is better, and in the end quicker, to use an abrasive cutting wheel for this purpose. A relatively fine-grained, 14-in. rubber-bonded wheel, $^1/_{16}$ in. thick, is used, which, for safety purposes, is operated at a speed of about 450 r.p.m. Subsequent grinding of the ring-section surface is unnecessary.

The cutting machine, in addition to usual safety precautions, should be provided with a water drip and drain, and with a suitable bottle-holding or clamping device.

* Presented at the Fortieth Annual Meeting, American Ceramic Society, New Orleans, La., March 31, 1938 (Glass Division). Received February 9, 1939.

[1] F. E. Wright, "Cords and Surface Markings in Glassware," *Jour. Amer. Ceram. Soc.*, **4** [8] 655–61 (1921).

[2] W. Ewald, "On Testing of the Annealing of Glass," *Glas-Ind.*, **37**, 131 (July, 1929).

[3] W. R. Lester, "Use of Polarizing Microscope in Factory Control," *Glass Ind.*, **13** [2] 19–20 (1932); *Ceram. Abs.*, **11** [4] 235 (1932).

If these precautions are not taken, the bottle can not be held rigidly, which will result in the breakage of both the bottles and the wheels.

V. Test

When a bottle is examined in a strain-finding polariscope, there are two positions at which the interference colors have a maximum intensity; the strains may be properly evaluated only when bottles are examined in these positions. The same principle applies to the polarizing microscope, which consequently must be used in the same way. The operator must determine the positions at which the maximum strain effects appear, and he must know the significance of the colors observed. The color for tension may readily be determined by flexing a strip of glass, preferably a partial ring section.

All samples should be examined in the same position, whether tension appears as a blue or as an orange color. Under low magnifications, strains will show as wide bands of color, the intensity of which will depend on the amount of strain present, and cords will usually appear as irregular streaks, ordinarily surrounded by areas of high strain. The ring-section examination is designed to evaluate these two conditions.

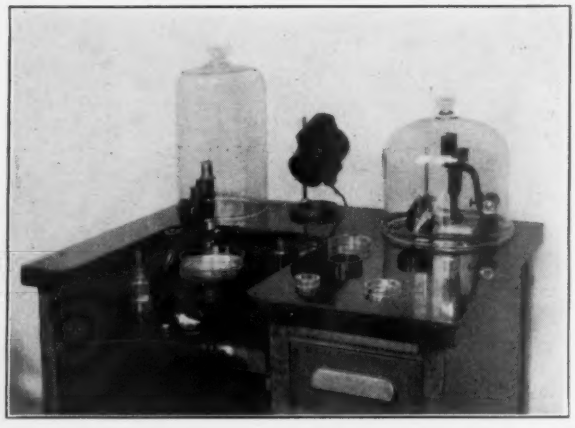


FIG. 1.

The presence of high ring-section strain is usually an indication of poor annealing, immediately showing the need of investigation and corrective measures. The quantitative determination of strain is a laboratory matter. For factory control, no strain measurements are usually made as examination is found to be sufficient.

In determining the degree of cordiness of a ring section, both the cords and the accompanying strains are taken into consideration. The *A*, *B*, *C* rating (shown in Fig. 3) is used, in which *A*+ is reserved for glass of optical quality. Although these ratings are not based on actual measurements of cord intensity or on the residual strain, they represent a careful evaluation of these conditions as determined by experience and performance. There are certain combinations which have proved to be dangerous and have resulted in excessive breakage, and there are also border-line combinations, which would be more dangerous in some types of bottles than in others.

Closer distinctions are sometimes attempted in which intermediate ratings (such as *C*−, which constitutes a border-line case) are used. Although an experienced operator can arrive at these intermediate classifications with reasonable accuracy, such a fine distinction usually is unnecessary.

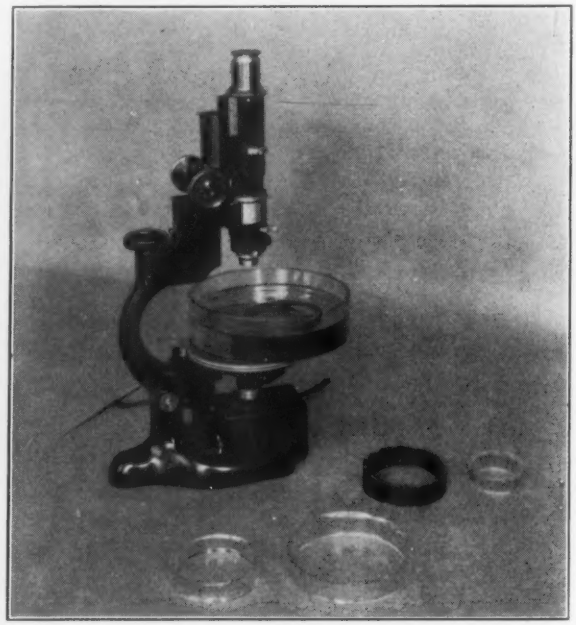


FIG. 2.

VI. Cords

Cords may be considered to be streaks of glass of a different composition from the mass in which they occur. They range in size from those of microscopic dimensions to those of visible proportions, and their chemical composition must range far beyond the limits of that of commercial glasses. The cords may be both highly siliceous and highly aluminous.

FIG. 3

Class	Microscope showing	Quality
A	Practically free from cords	Commercially perfect
B	Fine cords, well distributed; no strain banding	Highly commercial
C	Well distributed, fairly heavy, or irregular cords; localized areas of fine cords	Commercial
D	Localized areas of sharp cords; tension on outside; heavy cords	Dangerous
E	Cased or outer layer of glass in serious tension	Unusable

Eitel's[4] studies of the distribution of cords in containers show how the flow of the glass varies with feeding and

[4] W. Eitel, "Processes of Flow in Automatic Working of Glass in Owens Process, I," *Glastech. Ber.*, **10** [3] 121–25 (1932); *Ceram. Abs.*, **11** [6] 356 (1932); "II, Special Configuration in Finished Bottles," *Glastech. Ber.*, **10** [9] 469–77 (1932); *Ceram. Abs.*, **12** [1] 13 (1933).

Fig. 4

Fig. 5

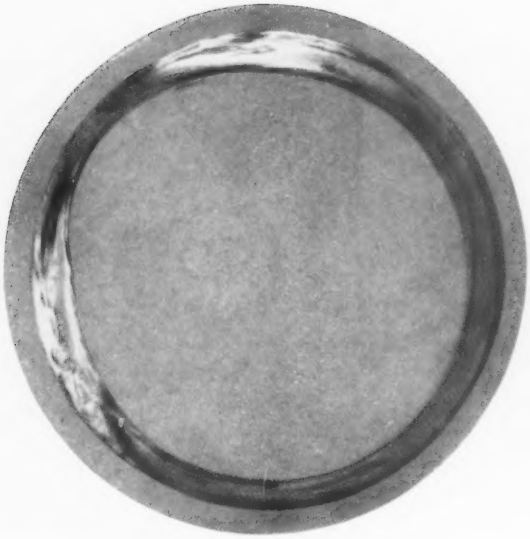


Fig. 6

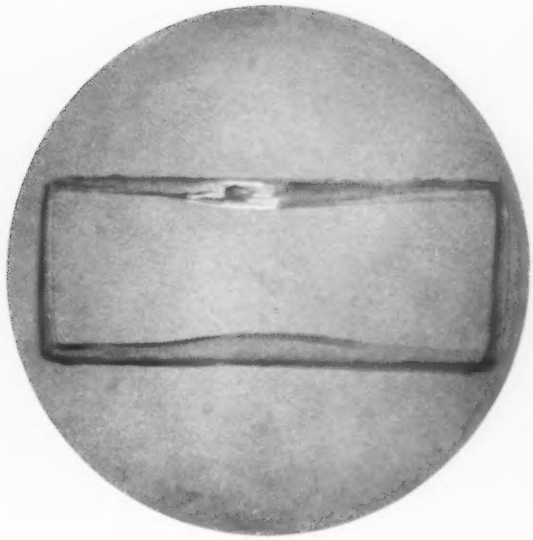


Fig. 7

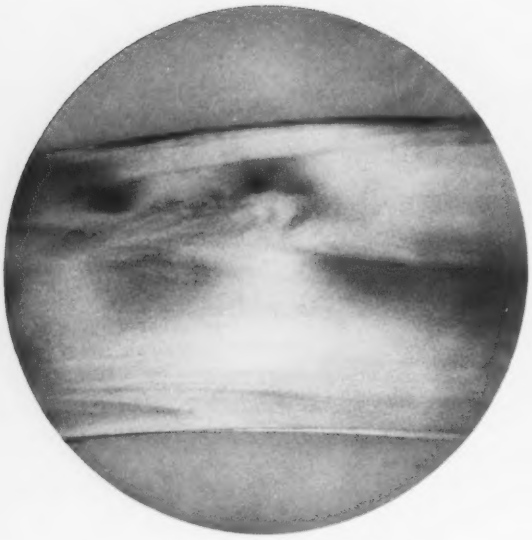


Fig. 8

Fig. 9

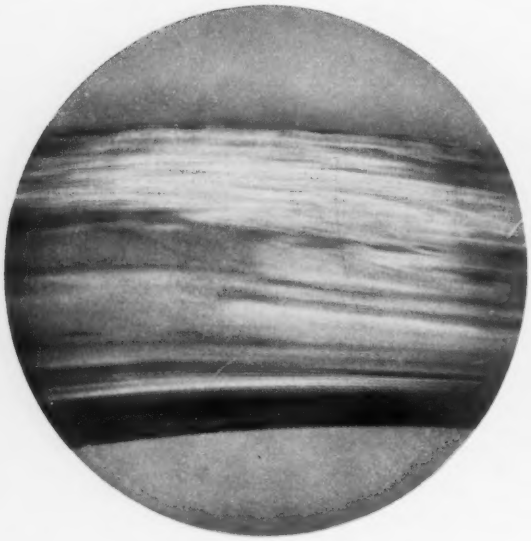


Fig. 10

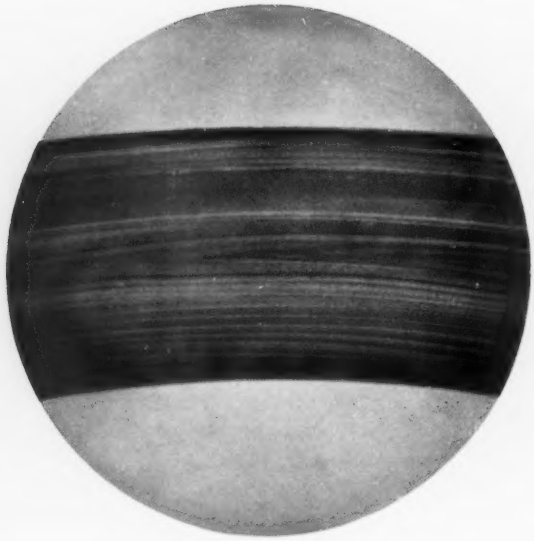


Fig. 11

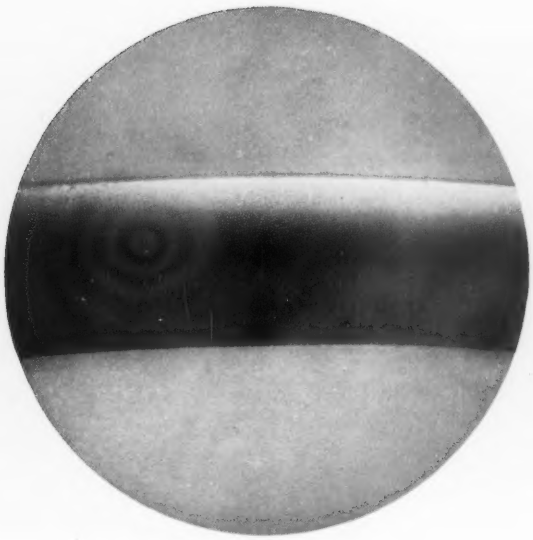


Fig. 12

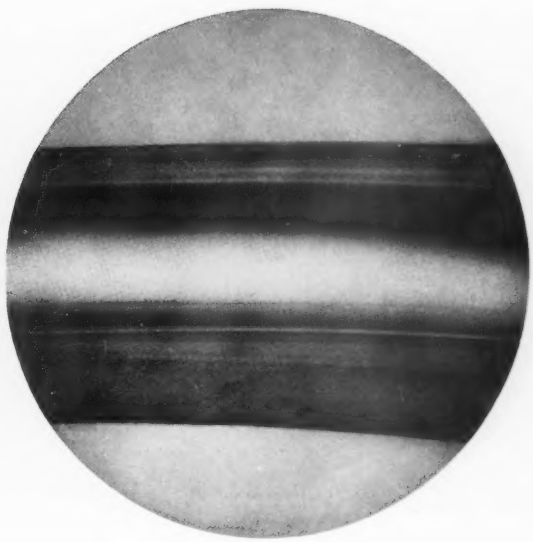


Fig. 13

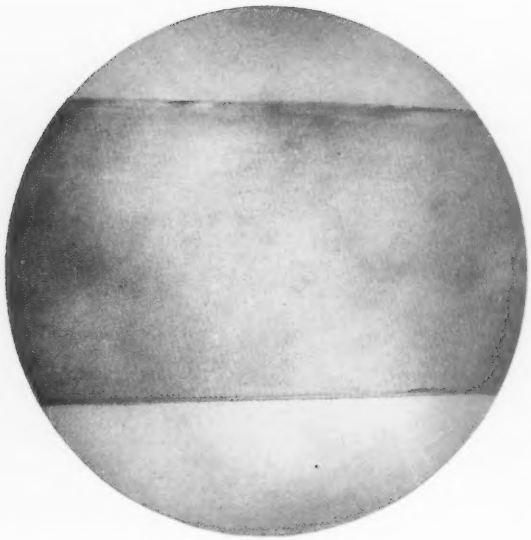


Fig. 14

Fig. 15

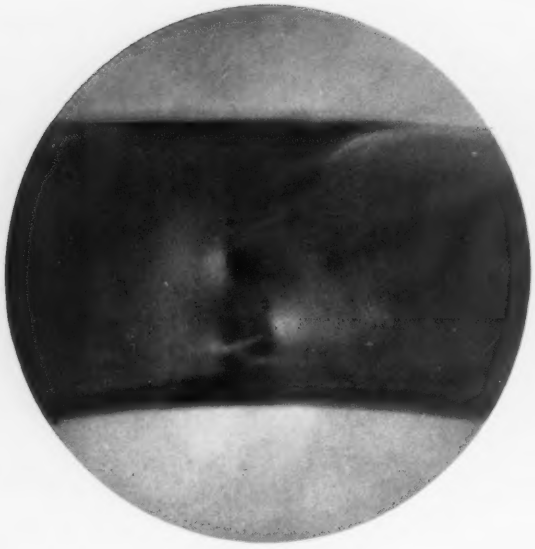


Fig. 16

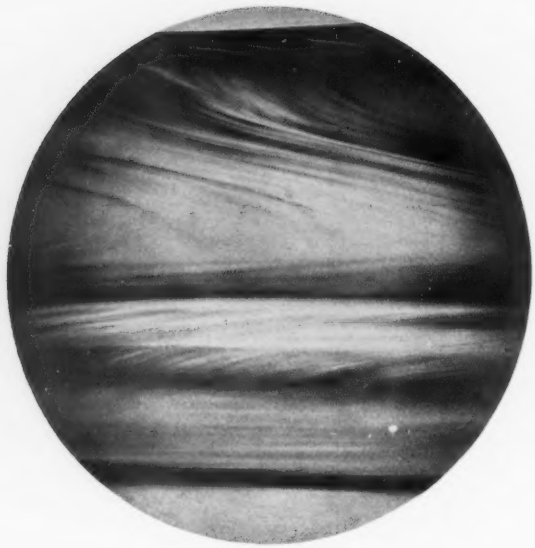


Fig. 17

forming operations. The "onion-peel" structure, which Eitel pictures, forms a basis for interpreting the characteristics of the cords observed.

Although it is practically impossible to draw up deadline specifications for classifying cords, there are certain characteristics which are known to be dangerous and which have resulted in serious breakage troubles. Most cords will fall under the following general classification: (1) outer layer or "casing" effect, (2) localized cords, or (3) general cordiness.

VII. "Outer-Layer" or "Casing" Effect

The wall of a bottle, in a number of instances, has consisted of two distinct and well-defined layers of glass of different chemical compositions. This "outer-layer" or "casing" effect, which is readily detected by ring-section examination, is unquestionably the most dangerous cordy condition encountered and has been the cause of excessive breakage, both at the factory and in service.

A cross section of a blue bottle, which was made shortly after a tank had been "changed over" from flint to blue glass, is shown in Fig. 4. A layer of colorless glass completely encased the blue, and, in some sections, it constituted at least one-half of the entire wall thickness of the bottle. Strain measurements made, on a section 5 cm. long from the side wall, indicated that the maximum tension amounted to 270 mμ per cm. path difference.

Analyses of the outer and inner layers of bottles showing this condition have revealed several differences in chemical composition; in each instance, the outer layer has had a greater density than the main body of the glass. The boundary line between the two layers is usually very sharp, and each layer has different cordy characteristics. The outer layer is usually in high tension.

This "outer-layer" effect is frequently found in flint bottles, of which Fig. 5 is a typical example.* It is particularly dangerous when it occurs in bottles subject to the "hot-pack" process, such as catsups or jam jars, and, in some instances, it has been the cause of serious breakage complaints.

The following analytical and density data were obtained on parts of a side-wall section from a flask which showed the "casing" effect. The glass, comprising the outer layer, had a lower SiO_2 content than that of the remainder of the section, and the "lime" and alkali contents were higher, accounting for the greater density, which appears to be a characteristic of this type of cordy condition.

	Inner layer (%)		Outer layer (%)	
SiO_2	73.5		72.8	
$Al_2O_3 + Fe_2O_3$	0.8		0.9	
CaO	4.6	7.9	4.8	8.2
MgO	3.3		3.4	
BaO	0.7		0.7	
$K_2O + Na_2O$	16.2		16.5	
B_2O_3	0.4		0.4	
SO_3	0.3		0.3	
Loss on ignition	0.1		0.1	
	99.9		99.9	
Density (4°C/4°C)	2.4726		2.4797	

* See Acknowledgment.

The casing, shown in Figs. 4 and 5, extended completely around the bottle, and the degree of cordiness was rated as *E*, "distinctly dangerous."

There have been instances where this condition appeared as a layer barely detectable with the microscope; in other instances, it has appeared as a much thicker layer, covering only a part of the outer surface. The author considers that even the slightest trace of this type of defect is undesirable and rates such bottles as "questionable." Experience has shown that the partial casing effect is dangerous and has resulted in breakage.

A characteristic of bottles showing the outer-layer effect is their susceptibility to "checking." This observation is based on the examination of a number of bottles whose surfaces showed a network of fine checks extending only through the outer layer.

Some of the causes for this type of inhomogeneity are recognized, and they include such factors as wrong batch proportioning, faulty batch scales, and batch segregation. The remedy often is not obvious, and it is sometimes necessary to drain the tank to eliminate the stratified condition which must have existed.

VIII. Localized Cords

A concentration of cords in one part of a bottle, known as "localized cords," is a condition readily detected with the polariscope. The condition appears as a heavy streak, usually surrounded by areas of high strain.

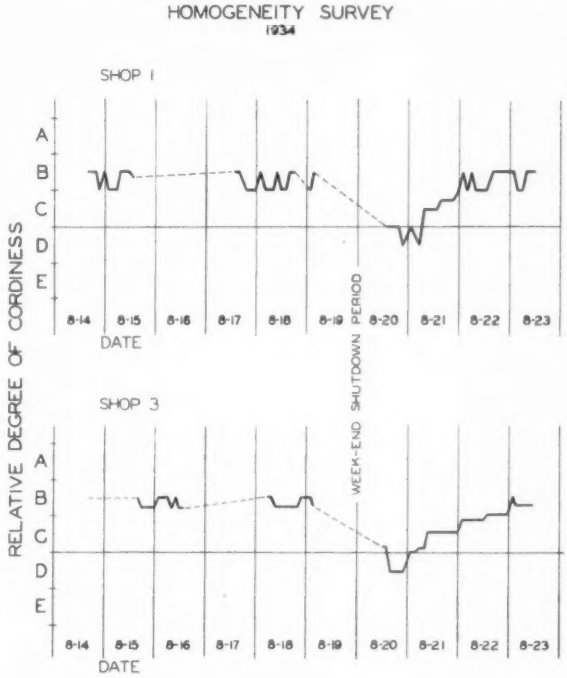


FIG. 18

A cross-section examination of the cords which appear as vertical streaks will reveal their true characteristics. Many show a wrinkling of the "onion-peel" structure and a resultant three-fold thickness. Such cords are not ordinarily surrounded by areas of high strain and therefore are not considered to be dangerous.

The most dangerous type consists of a grouping of sharp cords, as shown in Figs. 6 and 7. Such an area is always in high strain, and the remainder of the section usually consists of good quality glass. A bottle showing this condition will break spontaneously, and the fracture will originate along the path of the cord. Figures 8 and 9 show the details of the cordy areas in Figs. 6 and 7. The cords are very irregular, and the maximum tension exceeds 300 mμ per cm. path difference. Bottles showing these defects are rated as grade *D*.

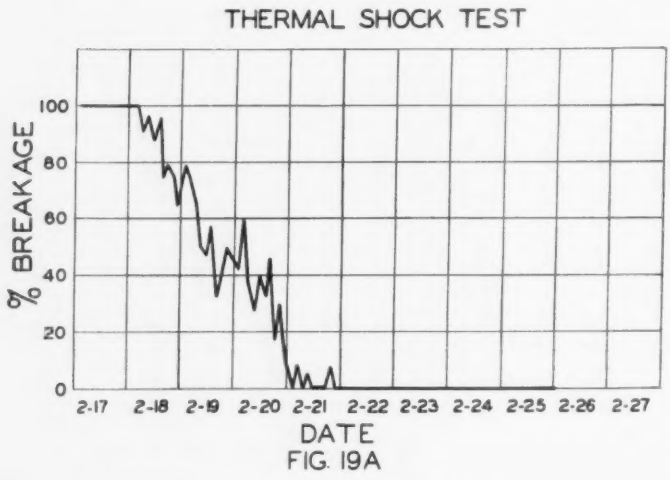


FIG. 19A

Figures 6 and 7 demonstrate the necessity for always having a complete ring section to examine, and they show how the distribution (wall thickness) of the bottle is affected by this type of cord. Any tendency toward lumpiness constitutes a serious manufacturing problem.

IX. General Cordiness

General cordiness, a random distribution of cords throughout the glass, is the most common type of defect encountered in practice. Some ring sections show only traces of cords, whereas others contain large numbers, surrounded by areas of high strain. Figure 10, which is a good example of dangerously cordy glass, shows a number of heavy cords well distributed throughout the glass. The over-all strain effect is very high, and the section would be rated as *D*.

Figure 11 shows general cordiness in green glass. This glass would be classed as "low commercial" in quality.

X. Ring-Section Strain

In arriving at an evaluation of the degree of cordiness, consideration must be given to the degree of strain in the glass after lehring, as distinguished from localized strain caused by cords. In bottle sections of cord-free glass, residual strain shows up as two wide bands of color, representing compression on the outside and tension on the inside. This condition, which has occurred at times in bottles from the outside rows of some lehrs, is not detected in the ordinary polariscopic test. It has been responsible for breakage troubles and should always be given consideration. Figure 12 is a fair example of this condition. Strain measurements made on typical sections have shown the maximum tension to be as high as 125 mμ per cm. path difference.

There are instances where a combination of considerable residual strain and strain caused by cords have been encountered. A distinction between these two kinds of strain may be obtained by a simple procedure. A vertical slot is cut through the section. The residual strain is thereby relieved, or nearly so, but the cord strain is unaffected.

XI. Practical Applications

A typical example of breakage troubles experienced with distillery flasks is shown in Figs. 13 and 14. Figure 13 shows a severe condition of general cordiness with a casing of tension on the outer surface. Figure 14 represents the same type of flask with which no breakage troubles were experienced. The glass in this section was practically free from cords and would be considered to be of good commercial quality in that respect.

Figure 15 shows a cross section from a piece of pressed ware with which breakage troubles were experienced in the factory. A heavy band of cords extends midway between the two surfaces, and the surrounding glass is highly strained. No information was available as to the cause of this condition.

Figure 16 shows the presence of localized cords of only moderate intensity in amber glass. Although this is an undesirable condition, it may not affect the strength of the container sufficiently to cause breakage.

The presence of heavy, localized cords can be the cause of excessive breakage, both at the factory and in service. A typical instance occurred at a factory which had just begun to use the ring-section examination. The bottles, which formerly would have passed the inspection department, were set aside as being of questionable quality. Within a few hours, the bottles started to break along the path of the cords, and were consequently rejected, thus probably avoiding a serious complaint. An investigation of the cause of the condition revealed that some crystalline material had lodged in the feeder. The material was

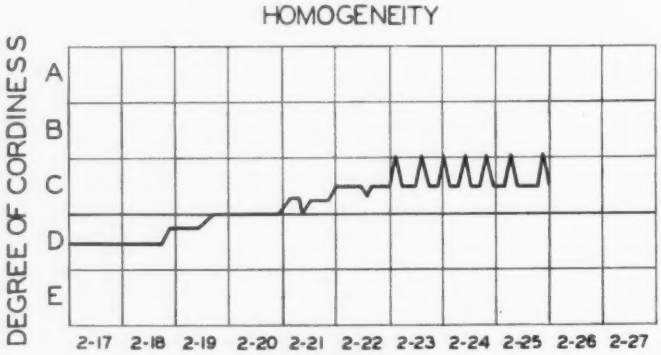


FIG. 19B

removed, and the localized cordy condition cleared up, thereby avoiding subsequent breakage.

In some bottles, cords will be more prominent in a basal section than in a section from the side wall. Figure 17 shows part of a basal section from a blue bottle which did not pass the heat-shock tests satisfactorily. The ordinary examination of ring sections revealed no particularly dangerous characteristics, but the outside of the basal section, which showed the presence of a heavy cord across the center, was in tension.

The ring-section test is used to make glass quality surveys, and in that respect it is of particular value in studying the efficiency of tank operation. Figure 18 is a chart of a survey made in 1934 to determine variations in quality of the glass. The investigation extended over a period of about ten days, during which time samples were taken at 2-hour intervals. The curves show that the glass from all shops was a very good quality until the shut-down period, and it continued to be of good quality for a few hours after starting up. There was then a period of dangerously cordy glass for about two shifts, following which the quality gradually improved, and by the middle of the week it was again highly commercial.

Figure 19 shows two curves, which, in a condensed form, present laboratory data related to breakage trouble experienced with pressure bottles. The upper curve shows their resistance to the usual heat-shock tests, in which breakage gradually diminished over a production period of four or five days, until the quality improved to such an extent that all of the bottles passed the tests satisfactorily. The lower curve shows the relationship between the homogeneity of the glass and the performance tests. For about two days, the bottles produced showed a distinct casing, the outside being in tension; this condition gradually diminished until, on the 21st day, it entirely disappeared.

XII. General Summary

While the original purpose of the ring-section type of examination was to control bottle quality, it is applied much more broadly. It may be used as a gauge of glass quality, and it is directly instrumental in making better glass. The real value of the test is obtained only when it is used in the broader sense.

If the results of the findings are not put to practical use, the test falls far short of its objective. Although in the case of structural defects, such as poor distribution or bad baffle marks, there are direct corrective methods of approach, the cause of cordy glass is not usually as apparent, and the remedy can be determined only by careful investigation of a multiplicity of possible causes. It calls for a survey of glassmelting practice, starting with the batch room, and an investigation of all the phases of manufacture up to the delivery of the glass to the forming machine.

The ring-section test is a valuable gauge to determine the general cordiness of a container. Because it is not essentially a performance test, it should be supplemented by other recognized tests. The method may be used in the factory to determine the trend in glass quality, thus pointing the way toward the prevention of poor quality glass. The tendency toward operating difficulties will thereby be minimized, and breakage hazards will be reduced.

Acknowledgment

The author gratefully acknowledges the assistance of Charles O. Dueval, Jr., American Thermos Bottle Co., Norwich, Conn., who made most of the original photographic slides used for the colored reproductions.

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WHAT TO SEE IN CHICAGO AND VICINITY

Adler Planetarium

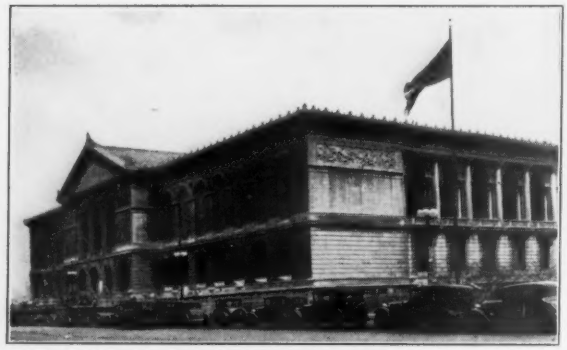
Located at Roosevelt Road and the Lake. Visitors can watch a pageant of the heavens move majestically across the great dome, while lecturers explain the mysteries of the universe. Brilliant lights whose position and coordinated movements faithfully represent those of the heavenly bodies are projected on the hemispherical dome by means of an intricate series of lenses. Open from 10 A.M. to 5 P.M. (Mon., Wed., Thurs., and Sat.), with lectures at 11 A.M. and 3 P.M. Open from 10 A.M. to 9 P.M. (Tues. and Fri.), with lectures at 11 A.M., 3 P.M., and 8 P.M. Open from 2 P.M. to 5 P.M. (Sun.) with lectures at 2:30 and 3:30 P.M. Free Wed., Sat., and Sun.; other days 25¢.

Architecture

In addition to the many skyscrapers, including the Palmolive, Tribune Tower, Field's, Civic Opera, and Daily News buildings, one should see the works of John Root, Lewis Sullivan, and Frank Lloyd Wright, whose collective works laid the foundations of modern architecture. Root's Monadnock Building and Sullivan's Walker Warehouse, Auditorium, and Carson, Pirie, Scott's store were revolutionary in their day, while Wright's Unity Temple (Oak Park) and "prairie" houses (Oak Park, River Forest, Riverside, Wilmette, Highland Park) had a tremendous influence abroad.

Art Institute

Michigan Avenue at Adams Street. Housing an excellent collection of the best work of ancient and modern masters of painting, sculpture, architecture, design, and other fine arts. The collections are among the finest in America. Free Wed., Sat., Sun., and holidays; other days 25¢; children free.



Chicago's famous Art Institute, one of the many attractions in Chicago, Ill., during the Forty-First Annual Meeting of the American Ceramic Society, April 16–22, 1939.

Board of Trade

LaSalle Street and Jackson Boulevard. Probably one of Chicago's most interesting spectacles is the Board of Trade in action. The intense activity in trading in wheat, corn, and other grains can be viewed from a special visitors' gallery.

Chicago Historical Society

North Avenue and Clark Street in Lincoln Park. This eighty-year old Society has a fine building which houses valuable historical documents, books, maps, portraits, and other subjects connected with the history of the U. S., particularly that of Chicago and the old Northwest Territory. Included among its treasures are the bed upon which Lincoln died and a suit of George Washington's. Free Mon., Wed., and Fri.; other days 25¢.

Chicago Zoölogical Gardens

31st Street, foot of 1st Avenue, Brookfield. Although located approximately 15 miles west of Chicago's Loop, the many interesting sights to see at the Brookfield Zoo should make the trip worth while. Here is a large collection of wild animals living as nearly as possible under natural conditions. In addition to several large buildings housing many hundreds of animals, the outdoor barless cages afford natural surroundings for the animals and confine them in a manner that is not really noticeable to the visitor. Free Thurs., Sat., and Sun.; other days 25¢.

Chinatown

22nd Street and Wentworth Avenue. An interesting racial community of Chicago. Those who visit this section will enjoy the several excellent restaurants and numerous stores offering oriental ware.

Elks National Memorial

Lakeview Avenue and Diversey Parkway. Erected as a memorial to the 70,000 Elks who served in the World War, it is the fraternity's national headquarters and overlooks Lincoln Park.

Field Museum of Natural History

Roosevelt Road and Lake Michigan. An eleven-acre building of Ionic-Greek architecture housing thousands of anthropological exhibits portraying the natural and cultural history of the world. It is one of the best museums of its kind in existence. Free Thurs., Sat., and Sun.; other days 25¢.

The Field Museum is another attraction Chicago has to offer to members of the American Ceramic Society who attend the Forty-First Annual Meeting.

Fort Dearborn

In Burnham Park on Leif Ericsson Drive. A replica of the pioneer stockade built at the mouth of the Chicago River in 1803. The original fort was destroyed following the Fort Dearborn massacre in 1812. This is one of the few buildings remaining which were part of the famous Century of Progress held in Chicago in 1933–1934.

Garfield Park Conservatory

In Garfield Park opposite Fulton Street. Said to be the world's largest glass conservatory, famed for its gorgeous seasonal displays of flowers.

"Gold Coast"

Lake Shore Drive from Oak Street to North Avenue. One of Chicago's handsomest sights is this broad parkway boulevard bordered on the west by the homes and apartments of some of the city's most prominent residents and on the east by beautiful Lake Michigan.

Northwestern University

The main campus is in Evanston some twelve miles north of the Loop, where the colleges of liberal arts and sciences are located. The other center of the University is situated at Lake Shore Drive and Chicago Avenue, where visitors can find the schools of medicine, dentistry, law, commerce, and journalism.

Northwestern University (downtown buildings, Chicago, Ill.)

Lincoln Park

On Lake Michigan, north of North Avenue. Chicago's largest park extending for several miles along the lake shore, with bathing beaches, large zoo, aquarium, conservatory, miles of bridle paths, lagoons for boating and skating, a large boat harbor, gun club, archery club, field house, and a restaurant. Within the park's environs are the Chicago Historical Society, Daily News Sanitarium, Chicago Academy of Sciences and Museum of Natural History, and the Chicago Yacht Club.

Merchandise Mart

Wells Street and Chicago River. The largest building in the world, containing more than 4,000,000 square feet of floor space. Several radio studios are located here, including that of the National Broadcasting Company.

Michigan Boulevard

Often called the most imposing thoroughfare in America. Grant Park to the east and the towering skyscrapers to the west afford a setting that is memorable.

Museum of Science and History

Jackson Park at the foot of Hyde Park Boulevard. This is the reconstructed Fine Arts Building of the World's Fair of 1893 and now houses this Museum dedicated to industry and the sciences. Moving models and actual machinery and instruments, many of which the visitor may operate himself, demonstrate scientific principles and their applications to industrial processes. The feature exhibit is a full-sized model coal mine which shows actual mining machinery in operation. Admission is free.

Navy Pier

At the foot of Grand Avenue. This great water terminal and amusement pier extends almost a mile into Lake Michigan. Passenger and freight steamers dock here.

Shedd Aquarium

Roosevelt Road and Lake Michigan. An octagonal structure containing a particularly fine collection of live fish from all parts of the United States and many foreign waters. Free Thurs., Sat., and Sun.; other days 25¢.

Soldier Field

In Grant Park south of Roosevelt Road. This tremendous amphitheater with a permanent seating capacity of 106,000 and maximum capacity of 145,000 is the largest open-air stadium in the world.

Union Stock Yards

Halsted Street, Pershing Road, Ashland Avenue, and 47th Street. One of Chicago's largest industries, where millions of sheep, hogs, and cattle are concentrated for slaughter and export. Tours can be made through a number of the great packing houses.

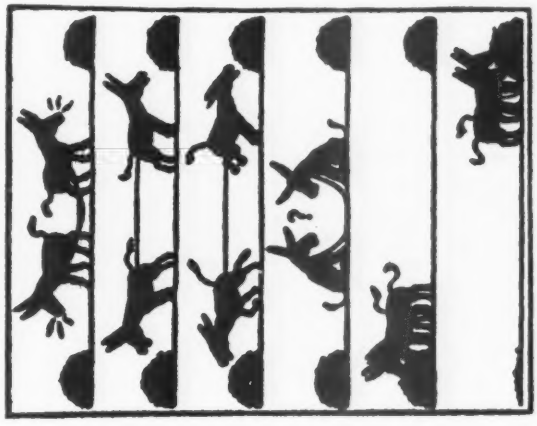
University of Chicago

Ellis Avenue and the Midway. One of the better known universities in the world occupying more than 100 acres along the Midway. Many buildings are patterned after the Gothic style of English universities, and the most interesting and impressive buildings are those around the Hutchinson Court, for which Oxford's most famed structures served as models. These are Ida Noyes Hall, Harper Library, Stagg Field, Oriental Institute, Billings Hospital, International House, and the new chapel.

Oriental Institute, University of Chicago

Water Tower

Michigan Boulevard and Chicago Avenue. An imposing limestone tower built in 1867 as part of the water supply system for the city at that time. It is now a relic that survived the great fire of 1871.



THE INSTITUTE OF CERAMIC ENGINEERS

Executive Committee
President: A. F. GREAVES-WALKER
Honorary Past-President: F. L. STEINHOFF
Vice-President: J. L. CARRUTHERS
Secretary: C. M. DODD
Trustee Representative: R. E. BIRCH

Telling Our Story

Descriptive material on ceramic engineering for young men who are preparing to enter college and for engineering students who have not yet reached the point of specialization in their college work is important. Some students enroll in ceramic engineering without an adequate idea of its scope, and consequently the mortality is unduly high.

Problems of this type were taken notice of some years ago by the engineering societies comprising the Engineers Council for Professional Development (E.C.P.D.). With the aid of the Engineering Foundation they prepared a 60-page pamphlet, Engineering: A Career, A Culture,* for distribution to students preparing to select a vocation and to their parents and teachers. It is a well-executed work, notable for its realistic presentation of the nature of engineering and the associations, rewards, and hardships which an engineer can expect.

Although this booklet is justly deserving of commendation, the ceramic engineer can read it through and through without detecting a suggestion that such a thing as ceramic engineering exists. This complete lack of recognition of ceramic engineering in many quarters is, of course, a principal reason for the existence of the Institute of Ceramic Engineers. There are no regrets for the loss of past opportunities, but it is important to see that the future tells a different story.

A.I.M.M.E. Coöperation

The Executive Committee has prepared material on ceramic engineering which the A.I.M.M.E. has kindly offered to make use of for a booklet on the mineral industries to be distributed to all high schools.

Another appreciated coöperation is that of Columbia University in accepting material on the history of ceramic engineering for a forthcoming book on the mineral industries.

Book Lists

Ideas differ as to just what should comprise a book list. Some compilers make them veritably complete bibliographies, while others feel that selectivity should be the primary aim. An excellent example of the latter type of book list is the compact Condensed Library of Engineering,† prepared single-handed, but ably, by Charles E. Lucke, Stevens Professor of Mechanical Engineering, Columbia University, who lists the book titles under ten subjects, each having eleven to twenty-four titles.

The E.C.P.D. has prepared a Selected Bibliography of Engineering Subjects in five sections as follows‡:

I. Mathematics, Mechanics, and Physics
II. Aeronautical and Civil Engineering
III. Chemical and Industrial Engineering
IV. Electrical and Mechanical Engineering
V. Metallurgical and Mining Engineering

The idea of a book list covering only ceramic subjects was started by the American Ceramic Society's 1936 Committee on Education. Such a list is now in the hands of the Society and is undergoing editorial study.

In connection with the activities of the E.C.P.D. in examining and accrediting engineering departments, the question regularly arises as to just what books should be available for student use. The selection of such a book list on ceramic engineering has been undertaken by a special Book List Committee (A. I. Andrews, *Chairman*) of the Institute of Ceramic Engineers. The aim is to designate a minimum list of titles which should be available for student use at all institutions having departments of ceramic engineering.

* Single copies 10 cents from E.C.P.D. Headquarters, 29 W. 39th St., New York, N. Y.

† While it lasts, this book list is obtainable from the Dean of the Engineering College, Columbia University, New York, N. Y.

‡ Available at 10 cents per section at the E.C.P.D. Headquarters, 29 W. 39th Street, New York, N. Y.

GOLDEN GATE GENERAL MEETING, SAN FRANCISCO, CALIF., AUGUST 6–12

ADVANCE PROGRAM ANNOUNCEMENT

1. California Clays

By W. F. DIETRICH: Teacher of Mining and Metallurgy, Sacramento Junior College, Sacramento

2. Present-Day Technology of Adsorbent Clay

By GEORGE SCHROTER: Filtrol Co., Los Angeles

An industry of national importance has been built around decolorizing clays. The author presents the high lights of the manufacture and use of such treated clays and presents a most interesting picture of the manifold uses of clay outside the ceramic field. Mr. Schroter is a geologist of distinction and is head of the department of exploration for the Filtrol Company which well qualifies him for the presentation of this interesting discussion.

3. Mineralogical and X-Ray Examination of Yet Unknown Hydrous Aluminum Silicate

By PAUL F. KERR: Dept. of Geology, Columbia University, New York, N. Y.

4. Chemical and Physical Properties of Yet Unknown Hydrous Aluminum Silicate

By VERNON R. SULLIVAN: Stockton Fire Brick Co., Pittsburg

5. Summary of the Occurrence, Properties, and Uses of the Vermiculite Deposits at Libby, Montana

By W. WURTH KRIEGEL: Montana School of Mines, Butte, Mont.

6. Plant Control of Raw Materials and Finished Products

By B. M. BURCHFIEL: Gladding, McBean, & Co., Los Angeles

Practical methods of determining suitability and maintaining uniformity of raw materials in certain Pacific Coast plants are described as they apply both to whiteware and heavy clay products. The idea of cheap but adequate tests is stressed. A systematic method of looking constantly for trouble and its sources is presented. This is to the end

that losses may be prevented entirely as far as possible and kept to a minimum by prompt correction when they occur and that uniformity of finished products may be maintained.

7. Methods of Body Preparation and Their Effect on Dust Pressing of Wall Tile

By R. F. Evans: Gladding, McBean, & Co., Los Angeles

The effect of various commercial methods of body preparation on a number of typical body compositions in relation to their effect on pressing behavior, density, and laminations is discussed. The method of preparation also has a material effect on such fired properties as shrinkage, porosity, and strength.

8. Progress in the Development of Kiln Furniture

By Clifford E. Tillotson: Tillotson Clay Products Co., Los Angeles

The causes of warpage and cracking in kiln furniture, especially in rapid-cycle, low-fire kilns have been studied with encouraging results in the compounding of special bodies which the author describes in his paper. An extensive case history is included, giving actual results obtained in the commercial utilization of the new product.

9. Little Known Expansion Strains in the Initial Firing of Ceramic Ware

By John Moffat, Jr., and Guy E. Sievert: Tillotson Clay Products Co., Los Angeles

In firing large pieces of ceramic ware, such as glass tank blocks, the investigators have endeavored to study the causes of cracking during the fire. Investigation of the thermal-expansion characteristics during the initial stages of the fire demonstrated to the authors the fact that relatively large strains occur at temperatures beyond the watersmoking period and extend through the oxidation period. The apparatus employed is a modified thermal-expansion equipment functioning with relatively large specimens of the actual body to be fired. The results of this investigation have been so successful that strains causing cracking and bloating of large masses of ware have been reduced to a minimum in the past few months. The method is equally applicable to the firing of all types of ceramic ware other than glass tank blocks. A description of the thermal-expansion apparatus employed is included in the paper.

10. Flint Clays and Flint-Clay Refractories of Southern California

By B. M. Burchfiel and Henry Mulryan: Gladding, McBean, & Co., Los Angeles

The occurrence and geology of the flint clays of Orange County, California, are described. As far as is known, these deposits are unique in the far West. Technical data both on the clays and refractories produced from them are given and discussed, and various uses are mentioned.

11. Mat Glazes and the Lime–Alumina–Silica System

By Hewitt Wilson: Electrotechnical Laboratory, Bureau of Mines, Norris, Tenn.

12. Development of Selenium Red Glazes

By A. Lee Bennett: Gladding, McBean, & Co., Los Angeles

The development of true (*i.e.*, somewhat translucent) ceramic glazes in pure orange shades is described. The study includes a discussion of the firing process and compositions. Beneficial and injurious glaze materials are enumerated. Successful ranges of glaze composition are given. Colors produced are classified by means of Ridgway's Color Standards and Nomenclature.

13. Some Studies of Carbon Glass

By Willi Cohn: Consulting Physicist, Berkeley

14. Glass

By W. A. Mahaffy: Owens-Illinois Pacific Coast Co., San Francisco

15. A Photomechanical Process for the Decoration of Tile and Other Flat Ceramic Ware

By Thomas S. Curtis: Thomas S. Curtis Laboratories, Huntington Park

A simple and practicable method is described for applying decorations in quantity production to all manner of ceramic ware having a flat or substantially plane surface. The process is offered to the ceramic industry as a dedication and carries no license fees or royalties for its use.

16. The Series Iron Oxides–Lime System

By W. J. Crook: Dept. of Metallurgy, Stanford University

The literature in general shows a considerable divergence of opinion regarding the basicity of the ferrite formed in steel-making slags. Evidence is presented which indicates that when mixtures of iron oxide and lime are melted under oxidizing conditions in contact with metallic iron, a ternary system between $CaO–FeO–Fe_2O_3$ prevails and that the compound formed between lime and ferric oxide has the composition $3CaO·Fe_2O_3$, except possibly for melts containing somewhat less than 10 mol. % CaO. A eutectic was found between FeO and $3CaO·Fe_2O_3$, which contains approximately 40 mol. % CaO. It is believed that when basic steel-making slags are considered, the ternary system $CaO–FeO–Fe_2O_3$ should be substituted for the binary system $CaO–Fe_2O_3$, which has been used generally in the past.

17. The Series Iron Oxides–Silica

By W. J. Crook

A review is presented of the previous work by the writer on the general series $FeO + Fe_2O_3 + SiO_2 + CaO(MgO)$ as related to steel-making slags, in which 12 quasi-quaternary mineral systems are formed. A "plane of partition" of the iron oxides (FeO and Fe_2O_3) is also shown to exist. A method is explained by which, having a partial analysis of a slag, the position of the slag in the representative tetrahedron may be found and the series of minerals formed may be determined.

The present paper is a study of the system iron oxides–silica under conditions of formation, with and without the presence of metallic iron. In the former case, two distinct eutectiferous series are formed, *i.e.*, (*a*) wüstite-fayalite and (*b*) fayalite-tridymite. The reducing power of metallic iron is so great that, substantially, the same proportions of FeO and Fe_2O_3 are obtained when melting is conducted either under strongly oxidizing conditions or in a neutral atmosphere. A "eutectoid" between magnetite and tridymite contains equal molecular proportions of SiO_2 and Fe_3O_4. When iron oxide and silica are heated at 1600°C higher in siliceous crucibles, the resulting melts consist essentially of tridymite and magnetite, forming an entirely different series than that obtained by melting in the presence of metallic iron. In connection with both series of melts, ferric oxide exhibits a much greater affinity for ferrous oxide than for silica.

18. Progress Report on the Warpage of Plates

By Hewitt Wilson and Staff: Electrotechnical Lab., Bureau of Mines, Norris, Tenn.

A report is presented on the coöperation between the Tennessee Valley Authority and the U. S. Bureau of Mines.

This discussion covers different types and possible causes of warpage from the mold to the kiln. An indicating and recording instrument for measuring rim warpage is described, and the warpage obtained from a large number

of commercial hotel plates is given. The experiments to control warpage were devoted mainly to (*a*) trueness of mold and jigger operation, (*b*) granular particle bedding in comparison with setter and ring placing, and (*c*) uniformity of firing.

19. Progress Report on Bisque Firing of China by Electricity

By Hewitt Wilson and Staff

A discussion is given of the firing of thin, translucent, all-American hollow-ware china bodies, hotel plate bungs, and heavy sanitary ware with exposed silicon-carbide electric resistors. Studies were made of the effect of soaking on uniformity throughout a firing chamber, 19 by 27 by 30 in., determined by cones, pyrometers, body shrinkage, and absorption. The cost of electrical equipment and operation is compared with reported data for combustion firing.

20. Progress Report on Electric Heating Elements for Ceramic Firing to 1400°C

By Hewitt Wilson, M. S. Nelson, and Staff

Oxidation of the heated graphite resistors in silicon-carbide tubes has been reduced by better end seals and protection to the graphite terminal leads. A report is given of the gas permeability of the tubes at high temperatures, the use of gases other than propane, and their pyrolysis at high temperatures. The experiments to eliminate the continuous application of propane gas to the interior of the protection tubes are described.

21. Fundamental Concepts on Thermal Conductivity of Refractory Materials

By A. Eucken; translated and presented by W. C. Rueckel: Battelle Memorial Inst., Columbus, Ohio

Eucken presents a theory of thermal conductivity based on the crystal, glass, and pore contents of refractory materials. A mathematical treatment, using a modified form of the Maxwell equation for one-, two-, and three-phase systems, is presented, and thermal conductivity values are calculated from values for crystal and glass phases found in silica, clay, sillimanite, and basic brick. The data show why essentially crystalline refractories, such as silicon carbide, etc., have a falling conductivity curve with increased temperature, and the thermal conductivity of clay brick increases with an increase in temperature.

LOCAL SECTIONS AND STUDENT BRANCHES

CENTRAL OHIO SECTION

The Central Ohio Section of the American Ceramic Society met on February 24, 1939, in the auditorium of the Battelle Memorial Institute.

Thirty members of the large group took advantage of the opportunity to hear a highly constructive talk by J. E. Wiss, supervisor of gypsum and lime sales, Industrial Div., U. S. Gypsum Company, on the subject of "Some Effects of Modernization of Ceramic Practices on the Use of Plaster."

The following officers for 1939–1940 were elected:

Chairman: Walter C. Rueckel
Secretary: G. H. Duncombe, Jr.
} Battelle Memorial Institute, Columbus, Ohio.

SOUTHERN CALIFORNIA SECTION

The Southern California Section held its first meeting of 1939 at the Hotel Clark in Los Angeles, the evening of February 21. Seventy members attended this meeting.

After the election of officers, the retiring Chairman, Thomas S. Curtis, introduced the speaker of the evening, A. L. Schreiber of the Vernon Potteries. Mr. Schreiber gave a thoroughly enjoyable discourse on "Potting Methods and High Lights of a Recent Trip throughout the Eastern States." A question period followed Mr. Schreiber's talk.

The following officers were elected for 1939–1940:

Chairman: H. R. Goodrich, Gladding, McBean, & Co., Los Angeles, Calif.

Vice-Chairman: F. A. McCann, Pacific Clay Products, Los Angeles, Calif.

Secretary: J. G. Stewart, Braun Corporation, Los Angeles, Calif.

—J. Gordon Stewart, *Secretary*

PITTSBURGH SECTION

The Pittsburgh Section of the American Ceramic Society met March 14, 1939, in the auditorium of Mellon Institute, Pittsburgh, Pa. The following program was presented: (1) "Development in Plastics," by H. F. Robertson, Carbide and Carbon Corp., and (2) "Rôle of Plastics in Industry," by E. R. Perry, Westinghouse Electric & Mfg. Co.

OHIO STATE UNIVERSITY

The Student Branch of the American Ceramic Society held its regular monthly meeting Wednesday, March 8, at 7:00 P.M. in Lord Hall. G. H. McIntyre, Director of Research, Ferro Enamel Corp., Cleveland, Ohio, was the speaker of the evening. Refreshments were served.

PENNSYLVANIA STATE COLLEGE

The Penn State Student Branch entertained with a dinner on February 21 in honor of V. V. Kelsey, president of the American Ceramic Society. Following the dinner, Mr. Kelsey spoke on "The Value of Education Today."

Harold White of the Pittsburgh Lava Crucible Co., Zelienople, Pa., addressed the Penn State students at the March meeting. His subject was "Crystalline Refractories."

—Kenneth S. Cowlin, *President*

DIRECTORY OF INDUSTRIAL RESEARCH LABORATORIES

The National Research Council has issued the sixth edition of a Directory of Industrial Research Laboratories (*N.R.C. Bulletin*, No. 102, 270 pp. (December, 1938)).

This Directory lists 1769 laboratories of manufacturing firms and technical consultants in the United States which carry on progressive research work of any nature, aside from routine examinations or testing. Taking into account laboratories for which no data could be obtained for this issue, the total number of industrial research laboratories in this country is estimated as about 1800.

This Directory in most cases gives the following items for the laboratories listed: address of the laboratory; name of the president of the corporation; name of the research director; classification of members of the research staff; total number of the laboratory personnel; research activities; coöperative researches (if any); and laboratory publications (if any). For sale by the National Research Council, 2101 Constitution Avenue, Washington, D. C $2.50 in paper; $3.00 in cloth.

NECROLOGY

GEORGE ALBERT HODSON

George A. Hodson, Chairman and Managing Director of Hathernware, Ltd., of Loughborough, England, died on April 22, 1938, at the age of sixty-two.

Mr. Hodson was born in Loughborough and succeeded at the age of 24 to the management of the brick and terra cotta works, then known as the Hathern Station Brick & Terra Cotta Co., a firm founded by his father and uncle. Under his administration, the firm grew to be one of the largest manufacturers of terra cotta in England. In 1915, the manufacture of chemical stoneware was begun, and this has since become one of the principal activities of the Company.

George Albert Hodson

Mr. Hodson was a great believer in the value of scientific societies; he became a member of the British Ceramic Society in 1908 and a member of the American Ceramic Society in 1918. He became President of the British Ceramic Society in 1930, being the first President to be nominated by the newly formed Building Materials Section of that Society. Mr. Hodson visited the United States with the British Ceramic Society in 1929, and he made another trip to America in 1936. He leaves a widow, a son, and a daughter.

GROW BY GETTING MORE NEW MEMBERS

NOTES

H. E. EBRIGHT WITH CHICAGO VITREOUS

Harry Ebright has joined the staff of the Chicago Vitreous Enamel Product Co. Mr. Ebright has been associated with the porcelain enameling industry for almost twenty years and has had a wide range of experience in connection with enamel manufacture and operation of enameling plants. He earned his degree in ceramic engineering at Ohio State University in 1922, and since that time has held sales, service, and executive positions in the enameling industry. Mr. Ebright assumed his new duties in sales and service work on March 1.

RESEARCH FELLOWSHIPS IN COAL AND NONMETALLICS

The University of Washington offers four fellowships in the College of Mines for research in coal and nonmetallics in coöperation with the United States Bureau of Mines. Fellows enter their duties on Saturday, July 1, 1939, and continue for 12 months. Payments under a fellowship are made at the end of each month and amount to $720 for the year.

The fellowships are open to graduates of universities and technical colleges who are qualified to undertake investigations. Ordinarily the appointees register as graduate students and become candidates for the degree of Master of Science in Mining or Metallurgical or Ceramic Engineering; occasionally an appointee registers for the Bachelor of Science degree in one of these curricula.

For the year 1939–1940, the following subjects have been selected for investigation:

(*1*) *Coal:* Problems in the treatment and utilization of coal and coke; combustion of coal on underfeed stokers.

(*2*) *Nonmetallics:* Problems in kaolin, talc, soapstone, olivine, silica-sand, diatomite, and other nonmetallics.

As applications will be passed upon late in April, each applicant should submit the following material promptly: (*a*) photograph, (*b*) copy of collegiate record from the registrar of college where he graduated, or will graduate in June, (*c*) statement of practical and technical experience, if any, (*d*) statement of experience or interest in investigations, such as will be carried on under the fellowships, and (*e*) letters from three persons, such as instructors and employers, covering specifically the applicant's character, ability, education, and experience.

—Milnor Roberts, *Dean*, College of Mines, University of Washington, Seattle, Wash.

FRANKLIN INSTITUTE HONORS NEW SAFETY GLASS DEVELOPMENT

In recognition of their work toward reducing travel hazards through development of modern safety glass, five corporations, two in the glass and three in the chemical fields, were honored by Franklin Institute in Philadelphia on March 31, 1939, at a dinner following the demonstration of a new and superior laminated safety glass. These five were E. I. du Pont de Nemours & Co., Inc., Pittsburgh Plate Glass Co., Carbide and Carbon Chemicals Corp., Libbey-Owens-Ford Glass Co., and Monsanto Chemical Co.

The occasion coincided with a formal announcement by the companies of a new Hi-Test laminated safety glass.

The ceremonies at the Institute were accompanied by a scientific demonstration of the properties of the new safety glass. The demonstration and exhibit will be continued at the Institute for the ensuing six months.

ROSTER OF CORPORATION MEMBERS

Abbé Engineering Co., New York, N. Y.
Abingdon Sanitary Mfg. Co., Abingdon, Ill.
A C Spark Plug Co., Flint, Mich.
Akron Porcelain Co., Akron, Ohio
American Gas Assn., New York, N. Y.
American Lava Corp., Chattanooga, Tenn.
American Nepheline Corp., Rochester, N. Y.
American Potash & Chemical Corp., New York, N. Y.
American Refractories Institute, Pittsburgh, Pa.
American Rolling Mill Co., Middletown, Ohio
American Sheet & Tin Plate Co., Pittsburgh, Pa.
American Stove Company, St. Louis, Mo.
Amsler-Morton Co., Pittsburgh, Pa.
Anchor Hocking Glass Corp., Lancaster, Ohio
Arketex Ceramic Corp., Brazil, Ind.
Atlantic Terra Cotta Co., Perth Amboy, N. J.

Babcock & Wilcox Co., New York, N. Y.
Ball Brothers Co., Muncie, Ind.
Baltimore Enamel & Novelty Co., Baltimore, Md.
Bausch & Lomb Optical Co., Rochester, N. Y.
Binghamton Brick Co., Inc., Binghamton, N. Y.
Blythe Colour Works, Ltd., Cresswell, Stoke-on-Trent, England
Bonnot Company, Canton, Ohio
Brockway Glass Company, Inc., Brockway, Pa.
Buck Glass Company, Baltimore, Md.
Buffalo Pottery, Buffalo, N. Y.

Canadian General Electric Co., Ltd., Peterborough, Ontario, Canada
Canton Stamping & Enameling Co., Canton, Ohio
Carborundum Company, Niagara Falls, N. Y.
Carr-Lowrey Glass Co., Baltimore, Md.
Celo Mines, Inc., Burnsville, N. C.
Central Silica Company, Glenford, Ohio
Ceramic Color & Chemical Mfg. Co., New Brighton, Pa.
Certain-Teed Products Corp., Buffalo, N. Y.
Champion Spark Plug Co., Detroit, Mich.
Chattanooga Glass Co., Chattanooga, Tenn.
Chicago Hardware Foundry Co., North Chicago, Ill.
Chicago Pottery Co., Chicago, Ill.
Chicago Vitreous Enamel Product Co., Cicero, Ill.
Clark, N., & Sons, San Francisco, Calif.
Commercial Decal Products, Inc., East Liverpool, Ohio
Coors Porcelain Company, Golden, Colo.
Corhart Refractories Co., Inc., Louisville, Ky.
Corning Glass Works, Corning, N. Y.
Crane Enamelware Company, Chattanooga, Tenn.
Crooksville China Co., Crooksville, Ohio
Crossley Machine Co., Trenton, N. J.
Crossman Company, South Amboy, N. J.
Crown Potteries Co., Evansville, Ind.

DeVilbiss Co., Toledo, Ohio
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Drakenfeld, B. F., & Co., New York, N. Y.
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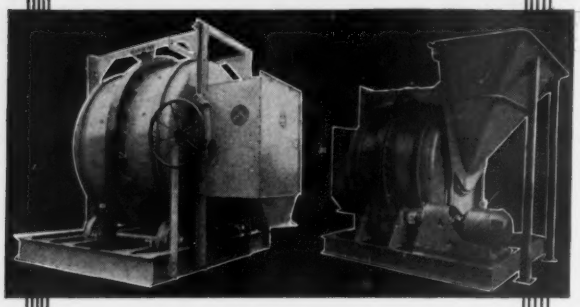

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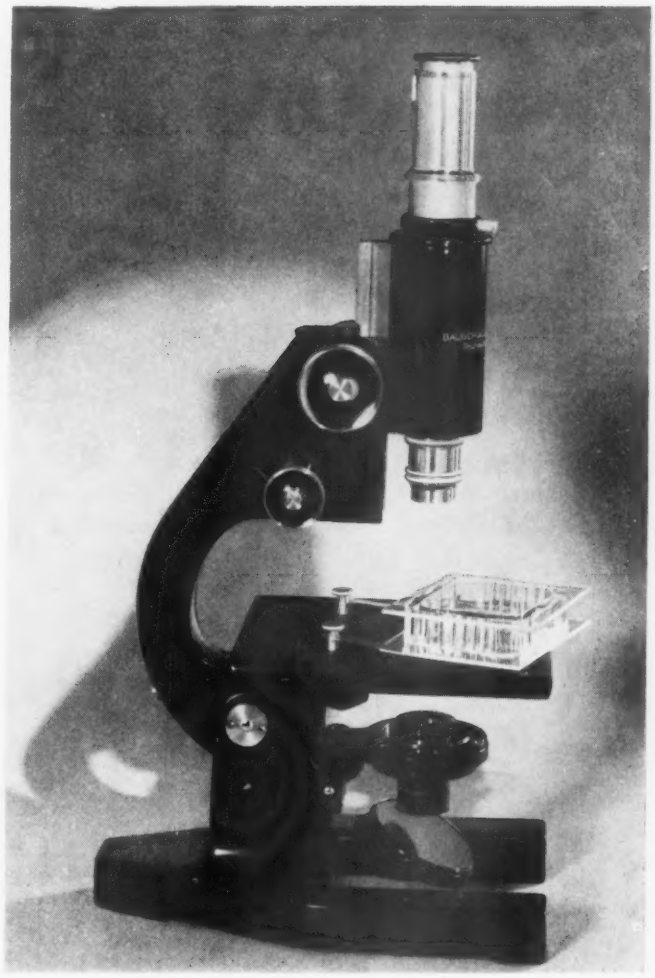

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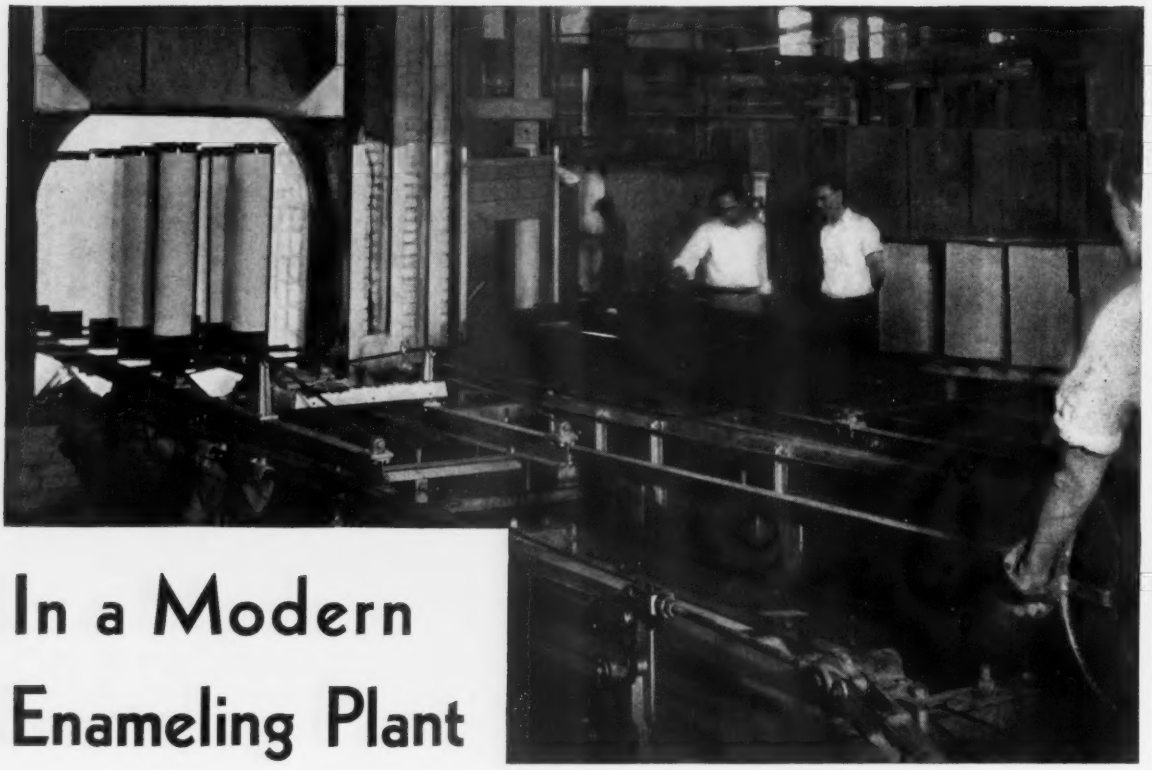

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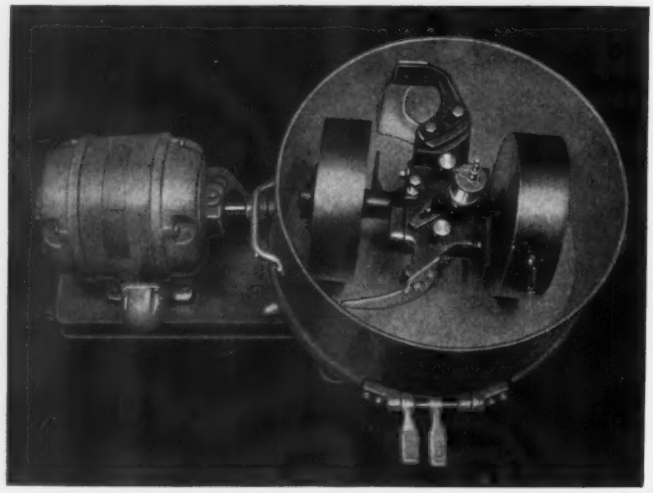

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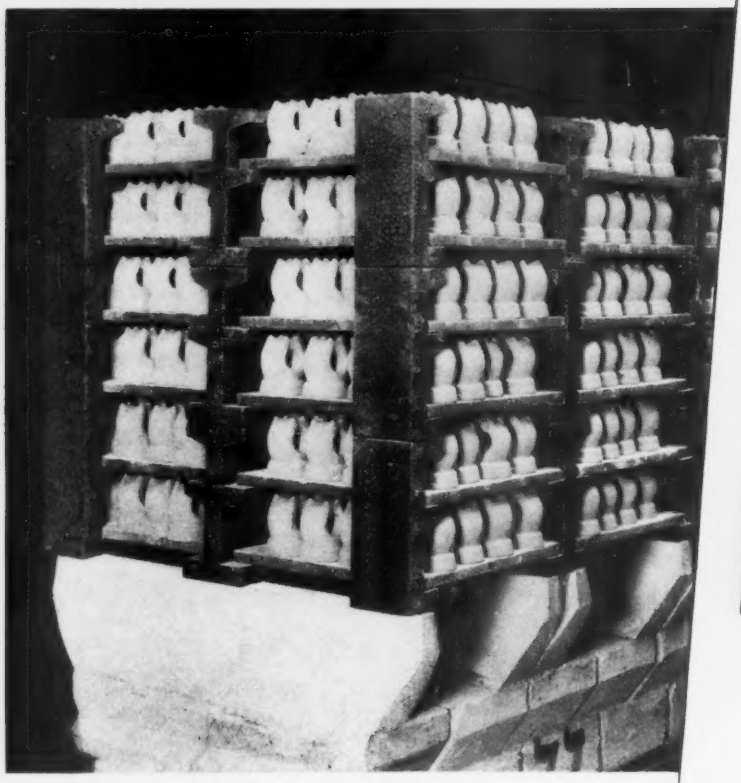

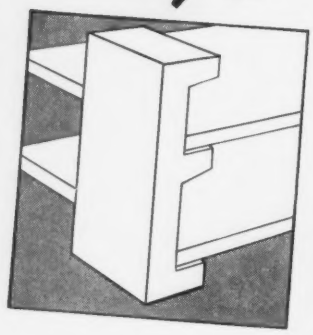

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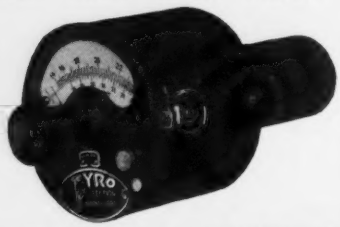

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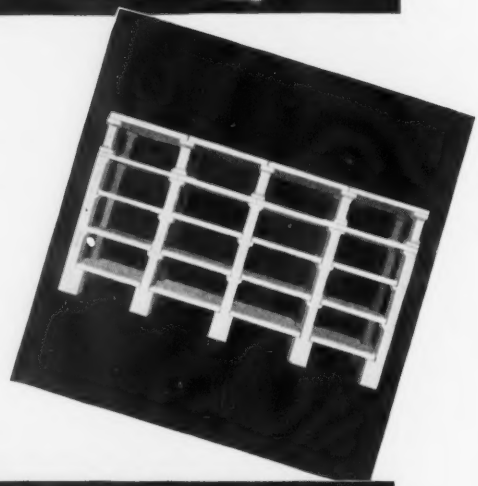

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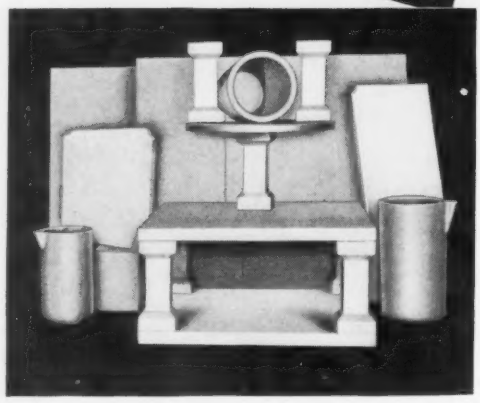

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